MONTANA HIGHWAY COMMISSION

PRELIMINARY LOCATION STUDY
DREXEL EAST AND WEST

ST. REGIS CANYON

INTERSTATE ROUTE INTERSTATE 90

OCTOBER 1968

MENASCO-McGUINN ASSOCIATES

M O N T A N A   H I G H W A Y   C O M M I S S I O N

PRELIMINARY LOCATION STUDY REPORT

DREXEL EAST AND WEST

ST. REGIS CANYON

INTERSTATE ROUTE 90

Menasco-McGuinn Associates
Helena, Montana
October, 1968

Menasco-McGuinn Associates
DESIGNERS-ENGINEERS
No. 6 South Park Ave.
Helena, Montana 59601

November 12, 1968

Mr. Lewis M. Chittim
State Highway Engineer
Montana Highway Commission
Helena, Montana

Dear Sir:

Transmitted herewith are 50 copies of the "Preliminary Location Study" for that portion of I-90 designated as Drexel East and West.

We wish to thank the members of the Montana Highway Commission, members of their staff, and other State and Federal agencies who have contributed to the preparation of the report.

The report contains a method of comparison and evaluation of all the highway design features we believe are important to this particular project, and is referred to as the "Highway Rating Index." Our recommendation is based upon the results of this "Highway Rating Index" and it is our hope it will provide the Montana Highway Commission with the basis for making an alignment selection on this project.

Very truly yours,

Ralph L. Menasco

Ralph L. Menasco, President

AUTHORITY

The following document has been prepared in accordance with a contract entered into between the Montana State Highway Commission and the firm of Menasco - McGuinn Associates, dated 29 March 1968.

The Montana Highway Commission, by authority granted under Section 32, Revised Codes of Montana 1947, directed the above firm to proceed with a Preliminary Location Study for that portion of Interstate I-90, Montana Project Number I-90-1 (12) 22-27 in Mineral County.

Review Comments & Notes

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PART I

GENERAL

A. INTRODUCTION

The following Preliminary Location Study has been prepared to evaluate and select a route through that portion of the St. Regis canyon on Interstate I-90 known as Drexel East and West.

The project study corridor begins at the Henderson junction and continues in an easterly direction for approximately 5.8 miles from the point of beginning.

Drexel, Montana, from which this project derives its name, is an electrical power station and siding for the Chicago, Milwaukee, St. Paul and Pacific Railroad.

Drexel is situated in the St. Regis canyon six miles west of the town of St. Regis, Montana, and some 27 miles east of the summit of Lookout Pass. The St. Regis canyon is a narrow canyon leading from Lookout Pass into the western portion of Montana. (For panoramic view of the study corridor, see the following pictures.)

The number of alignments studied in this report are as follows:

(1) Henderson Interchange

Station 100+00 to Station 127+45.46........0.527 Miles

(2) "20" Line

Station 127+45.46 to Station 406+44.45.....5.284 Miles

(3) "21" Line

Station 127+45.46 to Station 206+44.55.....1.496 Miles (3.78 miles beyond Station 206+44.55 is common to the "20" Line study.)

(4) "22" Line

Station 180+34.98 to Station 192+74.53.....0.235 Miles (1.002 miles ahead of Station 180+34.98 is common to the "23" Line study; 3.801 miles beyond Station 192+74.53 is common to the "20" Line study.)

(5) "23" Line

Station 127+45.46 to Station 395+80.39.....5.082 Miles

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PART 1 - Picture No. 1

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PART 1 - Picture No. 2

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(6) "24" Line

Station 127+45.46 to Station 415+95.38.... 5.464 Miles

Total Roadway Studied...............18.088 Miles

B. SCOPE OF STUDY

Given the easterly and westerly terminal points of the study corridor, as defined in the "Introduction", the study has analyzed and selected the most desirable and feasible route location through the study corridor.

In undertaking the study, we realize the great challenge that is presented by the terrain and by the beauty of the area to be traversed. We have attempted in all cases to study and to arrive at locations that are practical and yet aesthetically pleasing.

All alignments in this study meet the established interstate standards. It is our belief that for a highway to be functional, it must meet these standards. The driving public expects, and in the future will demand, all highways while remaining beautiful meet the functional aspects of a roadway. Our approach has been to give the touring public, which represents 47 percent of total traffic on this roadway, a tour of some five miles of the most pleasing scenery in all of western Montana.

Prior to the commencement of the study and throughout its development, it has been evident that many specific factors be analyzed before a recommendation could be concluded. In the past, the sole determination in route selection has been based primarily upon economics and construction requirements. We have endeavored in the report to go beyond this method of analyzation and establish a grade point system for aiding in the final route selection. In Part I-D under "General Procedures", we have narrated in depth the grade point system used.

C. DESIGN STANDARDS

"The Geometric Design Standards for the National System of Interstate and Defense Highways", adopted July 12, 1956, and revised April 12, 1963 by the American Association of State Highway Officials, are the design criteria in this study. For details and features not covered in these standards, the Design Manual of the Montana Highway Commission, and American Association of State Highway Officials, "A Policy on Geometric Design of Rural Highways" were used as guides.

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(1) Design Speed

In mountainous terrain, a minimum design speed of 50 miles per hour is permitted. However, the topography in this location is such that greater design speeds are attainable. All interstate alignments discussed in this report have alignments consistent with a minimum design speed of 55 miles per hour, or greater. It is recommended that 55 miles per hour be used as the minimum design speed for this portion of I-90.

Minimum design speed for ramps and frontage roads will be 25 miles per hour.

(2) Typical Sections

The minimum design speed of 55 miles per hour for the interstate meets the requirements of the classification "mountainous". It is recommended that all design features be controlled by the requirements for "mountainous topography". Affected by this requirement are median widths, outside shoulder widths and gradients.

The following Typical Roadway Section has been used for the interstate route throughout this study. The outside shoulder widths and ultimate median width conform to the "mountainous topography" classification. It is recommended that final design of the interstate be on the basis of this typical section.

(3) Gradients

The maximum gradient for the interstate will be 6 percent. The average gradient throughout all of the lines studied is +2 percent.

(4) Miscellaneous Standards

All features of the interstate highway, including ramps and frontage roads, will conform to the standards and criteria of the Montana Highway Commission and the American Association of State Highway Officials.

D. GENERAL PROCEDURES

As mentioned in Part I-A, a grade point system of analyzation has been established to select and recommend the best alignment. The procedure used in establishing the rating system is as follows:

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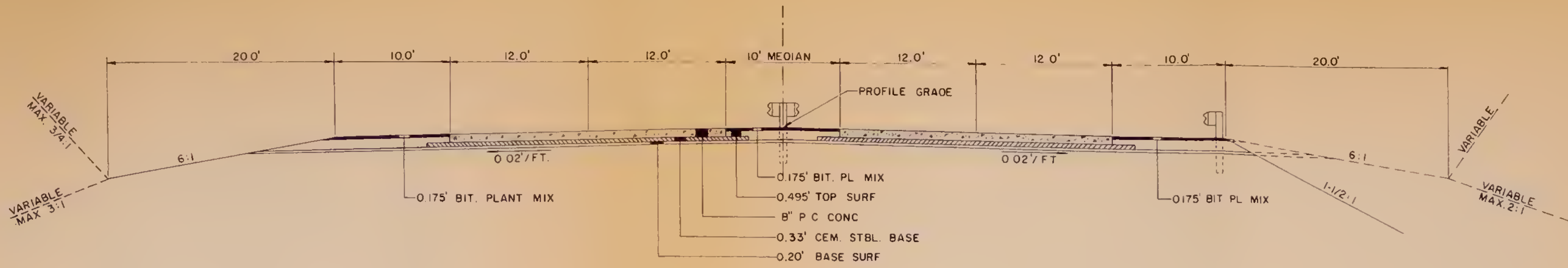
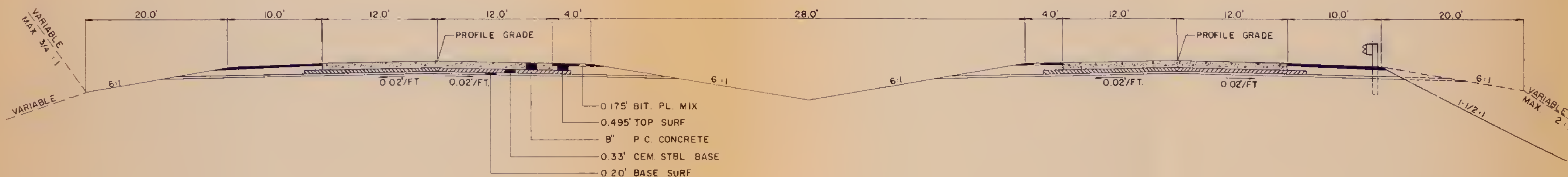
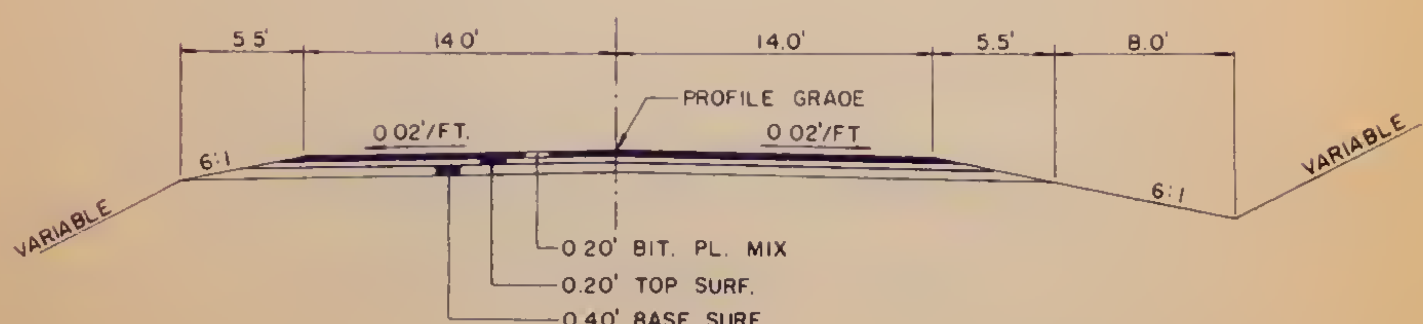


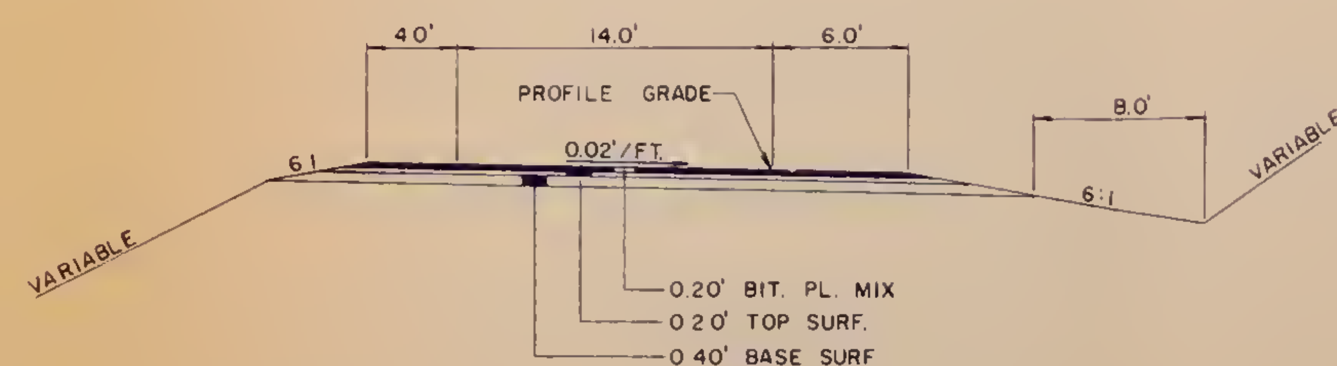
34' CENTERS
INTERSTATE



60' CENTERS
INTERSTATE



CROSS ROADS



RAMPS
INTERSTATE

STATE HIGHWAY COMMISSION
HELENA, MONTANA

TYPICAL
ROADWAY SECTIONS

MENASCO-McGUINN ASSOCIATES
HELENA, MONTANA

(1) Highway Rating Index

Nine items were picked as being representative of this project. These items were:

a. Horizontal Alignment
b. Vertical Alignment
c. Roadway Cross Section
d. Annual Cost
e. River Access and Conflict
f. Maintenance
g. Construction Methods
h. Scenic Evaluation
i. Utilities

The first five items were given 60 percent of the total of 100 percent for a weighted percentage of 12 percent each. Items six through nine were assigned the remaining 40 percent for a weighted percentage of 10 percent each.

On the "Highway Rating Index Summary", eight different combinations of alignments were compared. Items one through five have a weighted percentage of 12 percent; therefore, 12 divided by 8 equals 1.5 which is the mandatory difference between any two successive places. First place in any of the first five items was given a mandatory 12 points; second, 10.5; third, 9; fourth, 7.5; etc., to the eighth place to which 1.5 points were assigned.

In items six through nine, each item has a weighted percentage of ten percent. By dividing the ten by the number of alignments, eight, the mandatory difference is 1.25. The winner in these items receives a mandatory ten points; second place, 8.75; third, 7.50; fourth, 6.25; etc., to the eighth place which receives 1.25 points.

In the case of a tie, points for the tie positions are added together and divided by two in order to assign the points to the two tieing positions.

By adding the points "won" in each of the nine items, the selected route is the alignment with the most points.

Several comparisons were made to compare different features of the nine listed items in the "Highway Rating Index Summary" and each of these were rated. All data developed for the comparisons may be found under the representative section for that alignment. The comparisons and their rating method is as follows:

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(1) Horizontal Alignment

Five horizontal alignments were compared and rated. We have allowed ten points for each comparison. Therefore, the winner of each comparison under "Horizontal Alignment" receives ten points; second, eight; etc., to fifth place which receives two points.

a. Total Length in Miles

The shortest alignment was given ten points.

b. Curve Frequency

The least number of curves per mile was rated best.

c. Maximum Degree of Curvature

The alignment with the lowest maximum degree of curvature was rated best.

d. Average Degree of Curvature

The lowest average degree of curvature was assigned first.

e. Average Length of Curve

The average length of curve with the lowest value was given first place.

f. Average Deflection Per Curve

The lowest average deflection per curve was assigned the highest points.

g. Average Length of Curve

It is easier for a driver to negotiate a short steep curve than a longer one; therefore, the shortest average length of curve was given the higher points.

h. Total Deflection Angle

The least total deflection was given first place.

i. Average Deflection Per Mile

The least average deflection angle was given first place.

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j. Total Feet of Curvilinear Roadway

The alignment with the least amount of curvilinear roadway was considered the winner.

k. Percent of Curvilinear Roadway

The lowest percent of curvilinear roadway was assigned ten points.

l. Average Tangent Between Curves

The longest average tangent between curves was assigned the greatest points.

m. Total Number of Structures

Structures were considered a horizontal confinement; therefore, the alignment with the least number of structures was assigned ten points.

Any practical alignment for this project would be curvilinear. The problem, in fact, is to keep the roadway from becoming "tortuous". This reasoning is reflected in the above ratings.

(2) Vertical Alignment

Under this item, eight comparisons were made. Any practical vertical alignment on this project would be undulating. For this project, the problem is to keep the vertical alignment from becoming a "roller coaster" grade. The ratings applied to the following comparisons reflect this reasoning. Again, five alignments were compared and a mandatory ten points were assigned to the best alignment of each of the comparisons; eight points to the second; etc., to the eighth place which was given two points.

a. Total Length of Comparison

Total length of comparison is a function of the vertical alignment. The shortest length was assigned the highest number of points.

b. Curve Frequency Per Mile

The least number of curves per mile was given ten points.

c. Average K Factor

Average K Factor is derived as the rate of verti-

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cal curvature, length in feet per percent algebraic difference.

d. Maximum Grade

The alignment with the lowest maximum grade was considered the best.

e. Average Grade

The lowest average grade was assigned the highest rating.

f. Percent of Roadway with 5% Grade or More

The alignment with the least amount of roadway with 5 percent grade or greater was chosen as the winner and assigned ten points.

g. Percent of Roadway with 3% to 5% Grade

Same consideration as in "f" above.

h. Percent of Roadway with 2% to 3% Grade

Same consideration as in "f" above.

i. Percent of Roadway with Less than 2% Grade

The alignment with the highest percent of roadway having less than 2 percent grade was considered the best.

(3) Roadway Cross Section

The "20", "21" and "22" Lines have been studied on the basis of two roadway cross sections. The "23" and "24" Lines have been studied using one cross section only. These studies have been designated in the following manner:

a. Template A

Each alignment, with the exception of the "24" Line, has been studied using a 34 foot center-to-center cross section exclusively from the Henderson interchange (Station 172+45.46) to the end of each line studied. These studies are designated "Template A". In the case of the "23" Line, the 34 foot center-to-center cross section is the only cross section studied.

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b. Template B

For alignments "20", "21" and "22", an additional cross section has been studied from the Henderson interchange (Station 127+45.46) to the end of each line studied. These studies employ a combination of the 34 foot center-to-center cross section and a wider 60 foot center-to-center cross section. These studies are designated "Template B". The "24" Line, although listed under "Template B" in all cases, has several sections between the Henderson interchange and the Drexel interhcnage where the east and westbound lanes assume independent alignments. At no point on the "24" Line does the center-to-center distance fall below 60 feet.

This evaluation is made on the basis of which alignment and template provides the greatest amount of 60 foot center-to-center roadway. It is measured on the basis of percentage of 60 foot center-to-center roadway over the total length of each alignment. The "24" Line has a considerable amount of independent alignment which was considered superior to either the 34-foot or 60-foot centers.

c. 34' Center-to-Center

The alignment with the lowest percentage of 34 foot center-to-center roadway was rated the highest and assigned 16 points. The deviation from the ten-point must rating is due to the fact there are eight combinations of roadways to be considered under this item. We have retained the two-point spread between places.

d. 60' Center-to-Center

The alignment with the greatest percentage of wide median was considered the best and was assigned 16 points.

(4) Annual Cost

Under this item, only one comparison was made; that being the comparison of total annual cost. Total annual cost includes construction, right-of-way, maintenance, and user costs. The roadway having the lowest annual cost was assigned the highest points.

(5) River Access and Conflict

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a. Total River Access

The alignment that provides the most miles of river access was given ten points.

b. Percent of Present Access Retained

The roadway that retains the most miles of the existing PTW was rated superior.

c. Present PTW Relocated

To provide access under "a" above, the PTW was reconstructed in some areas. The alignment requiring the least amount of reconstruction was rated the best and assigned ten points.

d. Minor River Conflict

The alignment having the least amount of minor river conflict was rated best.

e. Major River Conflict

The roadway that results in the least amount of major river conflict was rated best and assigned ten points.

f. River Improvements

The alignment that has the most river improvement, that is, where the river is relocated into its original channel, was assigned ten points.

g. River Access Continuous

The alignment that provides the longest continuous river access was rated the best and was assigned ten points.

(6) Maintenance

The cost of maintenance of the surfacing was evaluated under Item 4. This evaluation was done to consider the following items:

a. Snow Removal

The widest median allows the greatest amount of snow storage and also provides the best drainage situation for melting snow; therefore, the align-

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ment with the greatest amount of wide median was awarded 16 points. Eight different alignment combinations were evaluated and the two-point spread was allowed between places.

b. Rock Removal

This item was compared on the amount of cut ditches from which rock would have to be removed. The alignment with the least amount of cut ditches was awarded 16 points.

c. Structure Maintenance

The alignment with the least length of bridges and retaining walls was rated the best and assigned 16 points.

d. Sanding

Sanding is first accomplished on steep grades and structures. Therefore, the alignment with the least amount of 3 percent grade, or greater, and length of structures was assigned 16 points.

(7) Construction Methods

We have made three comparisons under this item. Basically, these comparisons evaluate the convenience to the driving public during construction and the advantages to the contractor constructing the project. The items of comparison are as follows:

a. Traffic Control

The alignment with the least amount of construction and traffic conflict was assigned ten points.

b. Earthwork Balance

The roadway having the best earthwork balance was awarded ten points.

c. Simplicity

The roadway having the least amount of retaining walls and bridges was judged the best and was assigned ten points.

(8) Scenic Evaluation

Scenic evaluation was compared using three items which were:

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a. Panorama

The alignment with the most elevated roadway was considered the best.

b. Cut Slopes

Cut slopes were considered to be undesirable. Therefore, the alignment with the least cut slope area was considered the best and was assigned the highest points.

c. View Enhanced by High Fill

The alignment that had the greatest length of complete fill which provides a view on either side of the roadway was considered the best and assigned the most points.

(9) Utilities

The cost of relocating utilities was covered under Item 4. This comparison is an additional evaluation based upon the alignment offering the greatest versatility of access to utilities. The measurement for this comparison was the length of easement, with access, that can be provided. Therefore, the alignment that provides the greatest versatility to the utility comapnies was considered the best and was assigned the highest points.

E. TRAFFIC

The traffic movements for this portion of I-90 are unrestricted.

(1) Data

The basic traffic data was supplied by the Montana Highway Commission. Data furnished is as follows:

1965 A.D.T. = 1891
1991 A.D.T. = 6200
D.H.V. = 840
D. = 55-45
T. = 12.2%

(2) Design Year

1971 was used as the date of construction. A design year of 1981 was used; therefore, 73 percent of 1991 traffic was used for 1981 by prorating the 1965-1991 growth trend.

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(3) Operating Cost

For operating cost, truck costs were estimated at 3.6 times automobile costs. A vehicle mile cost of $0.0936 was used for grades less than 3 percent; $0.0963 for grades greater than 3 percent.

(4) Traffic Movements

For average daily movements, see Traffic Flow Diagram.

a. Henderson Interchange

The Henderson interchange provides access to the Twelvemile road and to the proposed rest area in the southwest quadrent of the interchange north of the St. Regis River.

b. Drexel Interchange

The Drexel interchange allows access to the Drexel Substation of the Milwaukee Railroad. Entrances and exits are provided for both westbound and eastbound traffic. This interchange also functions for reversing westbound traffic for the Ward Creek access point which is designed for eastbound traffic only. It also allows reversing Forest Service vehicles entering at the Forest Service road access point 1.72 miles east.

c. Ward Creek Access Point

The Ward Creek access point provides access to the Ward Creek drainage and its associated lumbering operations south of the project. This access point provides exit and entrance for eastbound traffic only, due to the limiting terrain conditions.

d. Forest Service Road Access

The Forest Service road access point is an exit lane followed by an entrance lane. The access point occurs where I-90 intercepts the present Forest Service road.

F. RIGHT-OF-WAY

The study corridor through which all the alignments traverse are located within Mineral County (County Seat - Superior, Montana).

Beginning at Station 100+00, at the Henderson interchange, the alignments pass through a large portion of the Lolo National Forest properties, through parcels of private ownerships, and through a small area of State land. Infringement of properties

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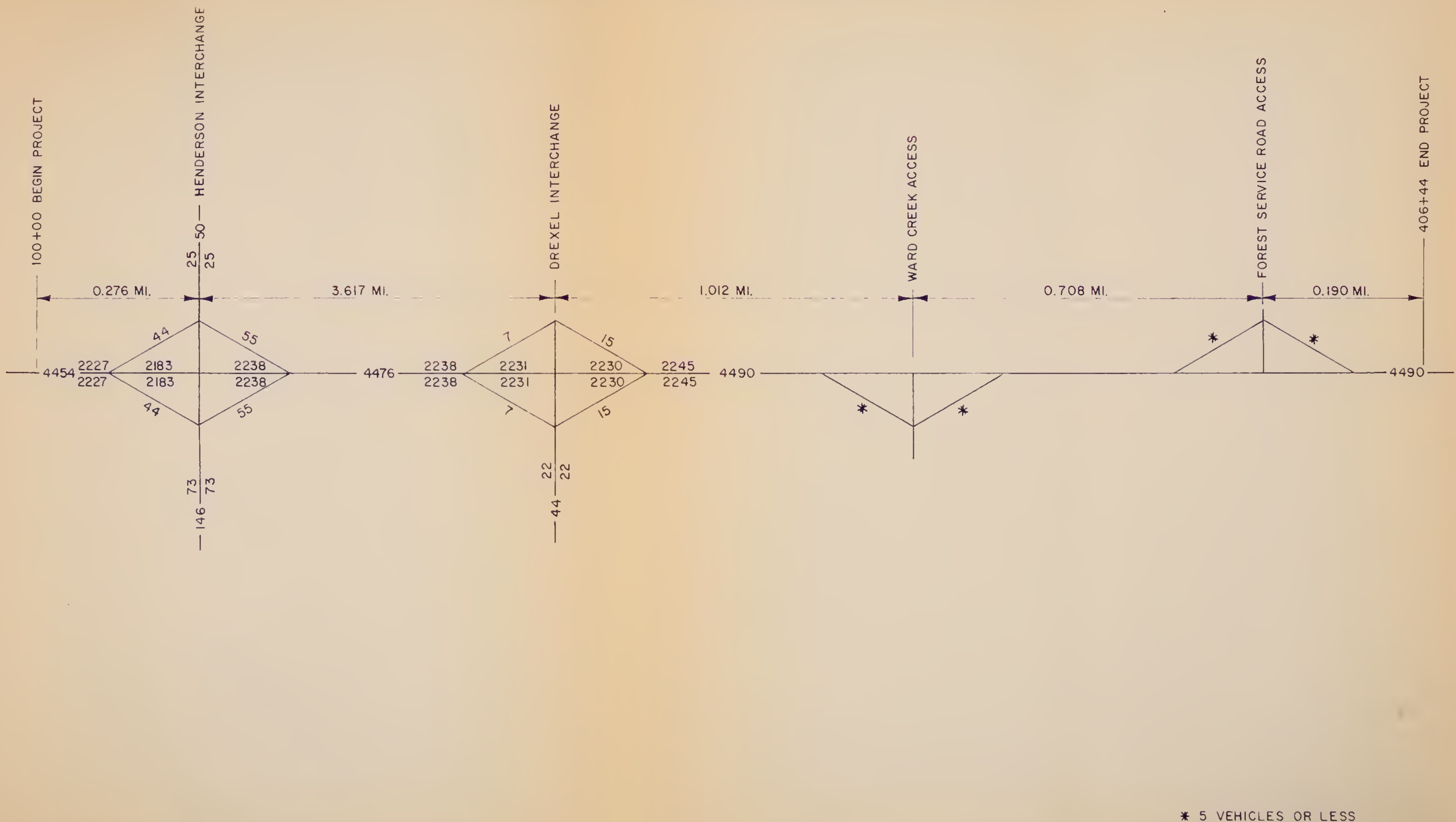
TRAFFIC FLOW DIAGRAM 1981 A.D.T.



owned by the Milwaukee Railroad do occur on portions of the "21", "22" and "23" alignments. Utility easements held by the Mountain States Telephone Company and the Milwaukee Railroad will require renegotiation for relocation.

Access to Boyd Mountain on the U.S. Forest Service road has been provided by an "off" ramp at Station 388+00 ("20" Line stationing).

The total highway right-of-way's southerly limits are formed by the northerly side of the St. Regis River. The northerly limits of right-of-way will be ten feet back of the top of cut slope parallel to the route selected. The total acreage required will be approximately 177 acres.

Access to the private properties held by DeCoursey at the Henderson interchange and the Knowles property at Drexel will be provided by respective interchanges. The Mayo property located in Section 10 T18N R29W will be totally isolated and without access. The total acreage of the Mayo property is 63 acres.

To resolve the access problems to this parcel may be accomplished by one of the following:

a. Provide an "on" and "off" ramp from the new alignment to the property.

b. Purchase the entire parcel; thus eliminating any severance damage to the property.

With the property free of capital improvements, the low appraisal value of the land, and with the small acreage involved, it is recommended the entire parcel be purchased.

Where right-of-way is required from private owners, all owners' land lying south of the northerly right-of-way limits will be taken. By doing so, there are no private owners left with "remainder parcels" cut off by the interstate.

A total of 20.6 acres will be taken from the 840-acre DeCoursey property. Approximately 37 acres are required from the Knowles property, leaving some 68.3 acres. From the 63-acre Mayo property, approximately 23 acres are needed, leaving 40 acres to the owner. The total amount of State-owned lands required will be less than one acre.

All of the foregoing figures have been developed assuming the alignment to be the "20" Line.

Where the "21", "22" and "23" Lines intersect the Milwaukee Railroad properties, indications are that the interstate con-

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struction limits will be beyond the railroad right-of-way. At these locations the alignments pass over the railroad with large structures. As a result, construction easements will be required from the railroad.

The following ownership map notes the locations of all properties mentioned above.

G. STRUCTURES

Structures are discussed subsequently in this report for each of the alignments considered and, therefore, will not be elaborated here.

H. GEOLOGY

(1) General

The St. Regis canyon, through which the proposed alignment passes, has been carved through a large anticline by glacial ice. This anticline is composed of three main rock masses: the Burke - Revette Formation, the St. Regis Formation, and the Wallace Formation, which developed in that order.

The predominant rock in this area correspond to these formations in the following manner:

a. Burke-Revette Formation - Quartzites
b. St. Regis Formation - Argillites
c. Wallace Formation - Quartzites and Argillites

The area has been intensely folded and faulted resulting in severe jointing throughout the area. The Osburn Fault, the major structural fault in the area, exits the canyon just north of Saltese.

The overburden throughout the area consists of unconsolidated sediments lying in three general conditions: (1) gravel terraces, (2) deposits of sandy gravel, and (3) talus overlying bedrock formations. The depth of overburden varies from a few feet to forty feet.

(2) Investigations

An extensive soils and materials investigation was made for this firm by Northern Testing Laboratories in November of 1967. This investigation was made over 3.4 miles of the St. Regis canyon in relation to Interstate I-90-1(12)11-16 (Saltese-Haugan). The area covered at that time is approximately five miles northwest of the area under investigation in this report.

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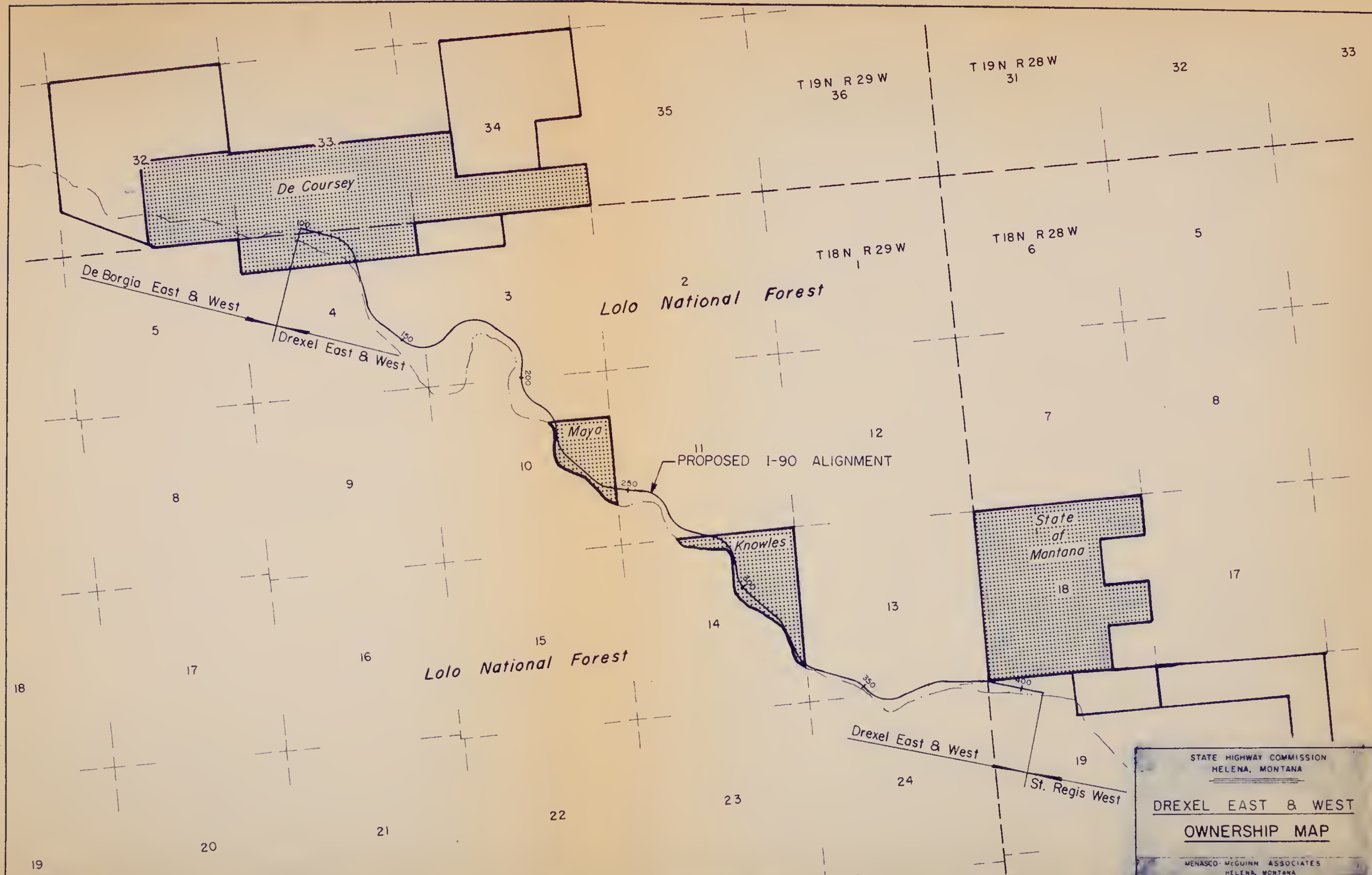

T 19N R 29 W
T 19N R 28 W
T 18N R 29 W
T 18N R 28 W
De Coursey
De Borgia East & West
Drexel East & West
Lolo National Forest
Maya
PROPOSED I-90 ALIGNMENT
Knowles
State of Montana
Lolo National Forest
Drexel East & West
St. Regis West
STATE HIGHWAY COMMISSION
HELENA, MONTANA
DREXEL EAST & WEST
OWNERSHIP MAP
MENASCO-McGUINN ASSOCIATES
HELENA, MONTANA

A preliminary investigation was made for the Drexel East and West study by the Montana State Highway Commission in 1965. The information compiled in this investigation corresponds precisely to the Northern Testing Laboratories' report where general geologic conditions are concerned.

Except for specific strike and dip calculations, the information and conclusions set forth in the Northern Testing Laboratories' report have been accepted as being applicable to the area under study at this time. The specific conditions referred to in this report (Drexel East and West) are taken from the Montana State Highway Commission's investigation.

(3) Conclusions and Recommendations

As was previously stated, the rock formations in this area are severely fractured and disoriented. A relatively complete knowledge of the type of rock to expect is available and a general idea of the structure and composition of the rock formations where cuts are proposed is available from the Montana State Highway Commission's report.

Generally, rock backslopes will vary from a minimum of 3/4:1 to a maximum of 1-1/4:1. Fill slopes will be composed of material removed from the rock cuts and it is recommended that slopes be no steeper than 1 - 1/4 : 1. The design slope used throughout this location study was 1-1/2:1.

Specifically, there are two problem areas which should receive special attention. They are located at approximately Stations 297+00 to 301+00 and Stations 351+00 to 357+00; their exact stationing depending upon the alignment in question. Investigation indicates the first of these locations is a potential slide area and experience has shown the latter to be a known slide area. The following is an outline of what is recommended for each alignment studied through these problem areas.

a. Area No. 1: Stations 297+00 to 301+00

The "20", "21" and "22" Lines have a common horizontal and vertical alignment at this point. Through this problem area, these alignments are in a low fill section and no difficulties should occur.

The "23" and "24" Lines call for a cut of thirty-five to zero feet through this area. Cut slopes will vary from sixty-five to zero feet. Slide control measures such as benching should be considered in this area.

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b. Area No. 2: Stations 351+00 to 357+00

In all cases, a cut of from forty to zero feet is proposed through this area. Cut slopes will be from ninety to 120 feet high. The horizontal alignment through this area is strictly confined by the river and railroad. It is recommended slide control measures be employed in lieu of attempting to locate the alignment around this area.

Due to the unconsolidated condition of the overburden, it is recommended all cut slopes be rounded at their intersection with the existing hill.

The following chart contains a data summary of the Montana State Highway Commission's report.

I. COST ESTIMATES

(1) Introduction

The following is an explanation of the procedure used to develop the total annual cost estimate. Where a cost item is common to all the alignments presented in this report, this item has been omitted from the comparison.

a. Clearing and Grubbing

The cost of clearing and grubbing would not vary significantly between the different alignments and has been omitted in the cost comparison.

b. Grading and Earthwork

The earthwork quantities, slope stake data, and mass ordinates were prepared by the Computer Sciences Corporation of Richland, Washington. The "Digital Terrain Model Design System" was employed in a Univac Computer. The ground control, or Digital Terrain Model, was prepared from aerial mapping supplied by the Montana State Highway Commission. This mapping, which has a horizontal scale of 1 inch equals 100 feet and a contour interval of two feet, was used in conjunction with a K & E Terrain Digitizer to prepare the terrain data cards used in the computer program. The design features of each alignment were coded and run through the computer for earthwork quantities. The alignment numbering system used in this report comes from this coding. A swell factor of ten percent was applied to all excavation quantities. The cost of all grading and earthwork operations are based on quantities developed by the above method.

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MONTANA HIGHWAY COMMISSION GEOLOGICAL REPORT

STATION	BACKSLOPE Lt. C/L	BACKSLOPE Rt. C/L	BENCHES (20' Width)	DITCH	REMARKS
100-135	1:1			15' Min.	Fractured Quartzite
135-141	3/4:1			Rock Design	Quartzite
141-156	1-1/4:1			15' Min.	Gravel & Talus
156-175	3/4:1	3/4:1	(1) @ 85' Vert. Ht.	Rock Design	Quartzite
175-200	1-1/4:1			15' Min.	Talus in Cut Gravel in Channel Change
200-226	1-1/4:1			15' Min.	Talus, Weathered Bedrock & Fractured Bedrock
215-227		1-1/4:1			Channel Change
226-235	1-1/4:1		(1) @ 85' Vert. Ht.	15' Min.	Jointed Quartzite
235-255	1-1/4:1		(1) @ 85' Vert. Ht.	15' Min.	Talus & Jointed Quartzite
255-273	1-1/4:1			15' Min.	Talus & Quartzite
273-276	3/4:1			Rock Design	Highly-jointed Rock
276-297	1-1/4:1			15' Min.	Gravel
297-301	Slide area: recommend no cut if possible.				
301-325	1-1/4:1			15' Min.	Gravel
325-351	1-1/4:1			15' Min.	Talus & Fractured Quartzite
351-357	1-3/4:1 Old slide area: recommend no cut if possible.				
357-370	3/4:1 & 1:1 Composite			Rock Design	Rock with Talus Overburden
370-End	1-1/4:1			15' Min.	Gravel & Talus

c. Drainage

The cost of this item was estimated from the actual drainage design on each alignment. A detailed discussion of these designs is found in Part I-J.

d. Structures

The cost of the structures required on each alignment was estimated on the basis of deck area in square feet. Twelve dollars per square foot was used for the average structures and twenty dollars per square foot was used for the high structures required on the "21", "22" and "23" Lines. The cost of retaining wall was estimated on the basis of linear feet at sixty dollars per linear foot based on an average height of 13 feet.

e. Utilities

The cost of relocating the utilities which are disturbed by each alignment was estimated according to the following schedule:

Steel Towers (100 KVA).......$1,000 each
Telephone Poles..............$ 23 each

f. Right-of-Way

A very limited amount of the total right-of-way is in private ownership. The amount of private lands taken is very nearly equal for all lines considered; therefore, no estimate of right-of-way costs was made for this comparison.

g. Surfacing

Because of the large amount of concrete proposed on this project (retaining walls, bridges, etc.), we have used Portland Cement Concrete as the surfacing material for the comparison between the different lines. We do not wish to imply that we have made an economic study into different paving types. The costs were estimated from the cross section quantities; pricing was accomplished by using the Montana Highway Commission average unit prices. The life of pavement was set at twenty years for purposes of computing the annual cost for this item.

h. Guard Rail, Fencing, Lighting and Signing

The guard rail quantities were estimated by using the Montana Highway Commission's "Method of Determining Need for Highway Guard Rail", as found in the "Field and Office Standards".

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Except for the Henderson interchange area, it is our opinion this project should not be fenced. The Henderson interchange is common for all alignments; therefore, we have not used fencing as an item in our economic comparison of the different lines.

Lighting was not used as a cost item in the comparison of lines due to the rural nature of the project area. It is our conclusion that no lighting should be included in the design of this project.

Signing of this project will be the same for all lines considered. The traffic movements, interchange locations and access points are all similar. Therefore, we have made no estimate of signing costs and they are not included in the comparison of lines.

i. Maintenance

The cost of maintaining each alignment was estimated at $3,000 per mile annually for 4-lane interstate and $1,500 per mile annually for ramps and crossroads.

j. Operating Cost (Road User Cost)

Operating costs were estimated according to the following schedule:

(1) Grades less than 3%

Automobile cost:
ADT x 87.8% x $0.0936 x length in miles
Truck cost:
ADT x 12.2% x $0.3370 x length in miles

(2) Grades greater than 3%

Automobile cost:
ADT x 87.8% x $0.0963 x length in miles
Truck cost:
ADT x 12.2% x $0.3467 x length in miles

k. Capital Recovery Factor

To arrive at an estimated annual cost, the following capital recovery factors based on 6 percent interest were applied to each construction cost item:

(1) 20 Years: Capital Recovery Factor = 0.0872

Guard Rail
Base, Surfacing and Pavement
Rest Areas
Traffic Control Devices

Review Comments & Notes

(2) 40 Years: Capital Recovery Factor = 0.0665

Grading, Earthwork and Channel Changes
Drainage

(3) 50 Years: Capital Recovery Factor = 0.0634

Major Structures and Retaining Walls
Utilities

J. DRAINAGE

The Interstate I-90 routing parallels the St. Regis River from its head waters at Lookout Pass to its merger with the Clark Fork River at St. Regis, Montana.

The major tributaries of the St. Regis River, within the project limits, are:

(1) Twelvemile Creek located at the Henderson interchange and contributing flow from a northwesterly direction.

(2) Henderson Creek located downstream approximately one-half mile from the mouth of Twelvemile Creek, and draining those areas to the southwest portion of the project.

(3) Ward Creek located downstream approximately four and one-half miles from Twelvemile Creek and contributing flow from a southwesterly direction from the project.

The drainage areas that contribute to the St. Regis River are nearly square to circular in shape. Drainage areas of this shape tend to cause higher crests for shorter duration than do narrow, elongated areas.

The vegetation of the area averages 75 percent timber, standing on 2:1 slopes. The area south of the river contains more timber per acre than the northern area. The sparseness caused by logging and fires is approximately equal on both sides. The north-facing slopes have noticeably more dense tree cover than the slopes receiving more direct sun. This difference in density of vegetation is offset by the difference in time of concentration for the drainage areas. The peak discharge in c.f.s. entering the St. Regis River from the drainage areas on the north is approximately equal to the discharge from the drainage areas on the south.

The flow data for the St. Regis River used in this report was developed from the data complied at a U.S.G.S. gaging station (No. 12-3540) located 5.3 miles downstream from the end of

Review Comments & Notes

project. At this gage, the St. Regis River has drained 303 square miles. Using this as a factor, the flow volume at the gaging station was prorated on a c.f.s. per square mile basis to determine the approximate discharge at desired points along the study alignments.

The method of prorating downstream data to establish discharge rates at significant locations in this study was chosen following an interview with Mr. Grant T. Buswell of the U.S.G.S. Mr. Buswell indicated that stream flow records from similar adjacent drainage areas in western Montana differed by as much as 10:1. These differences are caused by factors such as underground streams removing flow, springs contributing to flow, etc. Due to these factors, for which no allowances can be made when using a rational formula method, the method of prorating downstream data was employed in this study.

By studying several cross sections of the existing channel, the most critical point, hydraulically, was found to occur at approximately Station 392 + 00 ("23" Line) near the east end of the project. This cross section was chosen because it is narrower than others and it occurs at an abrubt change in the river gradient. The cross section has a 50-foot bottom with side slopes of 2:1 and 1:1, and a Manning coefficient of roughness of n = 0.033. From this point, the downstream velocity (based upon a 0.74 percent gradient) should indicate a maximum velocity for the project. Likewise, the upstream depth (based upon a 0.38 percent gradient) should approximate a maximum depth for this project. The average gradient of the river throughout the study corridor is 0.545 percent.

This study was made using contour maps prepared from aerial photographs taken June 14 - 15 of 1967. At that time, the level of the river at the critical point in question was 2,766 feet (m.s.l.). The discharge rate was 1,850 c.f.s. The upstream depth was 4.5 feet with a velocity of 7.0 f.p.s. and downstream, the depth was 4.0 feet with a velocity of 9.0 f.p.s. The minimum centerline elevation above the river at any point has been established as 14.5 feet above the high - water level on June 14-15, 1967. The 14.5-foot criteria comes from a study of the following maximum flow conditions.

According to interviews with residents of the area by Mr. Buswell of the U.S.G.S. and Mrs. Ruth McCallum, ("An Anthology of St. Regis, Montana", by Ruth McCallum, 1959; Montana Historical Library), the maximum recorded discharge of 25,000 c.f.s. occurred in late December of 1933. The conditions at the critical section (Station 392 + 00) were 19.0 feet of depth at 16.0 f.p.s. upstream and 17.5 of depth at 19.0 f.p.s. downstream. The discharge recorded at this time is twice as large as the second highest recorded discharge. The second highest recorded conditions occurred in 1954 when the discharge rate reached 10,000

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c.f.s. at the critical section. The upstream depth was 11.5 feet and the downstream depth was 10.0 feet.

The unusually high volume of water in December, 1933, was caused by virtually all snow being rapidly converted into runoff due to two factors: (1) a wet snowpack subjected to a warm rain, and (2) the surface absorption was negligable due to frost. The entire area contributed simultaneously. Ordinarily, the melting takes place over a prolonged period as the angle of the sun's rays varies. Haugan weather records during this period show sub-freezing, daily - high temperatures December 15 - 16; and above-freezing, daily - low temperatures December 19 - 23. The 24 - hour rainfall measurements at Haugen were:

December 20 - 0.94 inches
December 21 - 1.57 inches
December 22 - 1.87 inches
(Climatological Data, Montana, December, 1933; U. S. Weather Bureau)

In Haugan, which has an average December total precipitation of 4.66 inches, a rainfall of 4.4 inches in three days is a climatological anomaly. However, these conditions are not sufficiently above normal to predict they cannot recur or be exceeded.

K. UTILITIES

Two utilities will require partial relocation as a result of the proposed new highway location. These utilities are a transcontinental telephone overhead line and a 100 KVA steel tower and timber "H" pole line. The utilities follow the proposed route locations for the entire length of the project.

The telephone service was constructed approximately forty years ago. Since that time, maintenance has been accomplished from an access road up the St. Regis River from the town of St. Regis, and later from the present U.S. Highway 10. The present line replacement in other areas has been constructed utilizing underground cable. It has been rumored that Mountain States Telephone Company is investigating the possibility of relocating the entire line over the old "Camel Hump" alignment.

The "20" Line alignment has the greatest amount of conflict with the present telephone location. It is estimated approximately 209 poles will require relocation. The other alignments, "21", "22", "23" and "24", would require the removal of approximately 143 poles per alignment.

The 100 KVA power transmission line maintains an alignment which lays primarily along the existing PTW and the river bot-

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tom. As a result, the "20" Line does not conflict with the service at any point between Henderson and Drexel. The "21" Line will remove some eight structures along its present location. The "22" Line will remove six structures, while the "23" Line will require removal of eight structures.

Access for line maintenance for both the telephone and power service can be maintained along the PTW between Henderson and Drexel for either of the "20", "21" and "22" Lines. Lines "23" and "24" will not provide any access to the services along the PTW.

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Part II
Henderson
Interchange

PART II

HENDERSON INTERCHANGE AREA

A. INTRODUCTION

The Henderson interchange area is referred to frequently throughout this report. It is the first 0.52 miles of the study beginning at Station 100+00 and going to Station 127+45.46. It is our belief that a single design through this area is sufficient; therefore, the alignment presented is common to all lines studied in this report.

The alignment presented is designed to serve two purposes: (1) to provide an interchange which will serve Twelvemile road and a proposed rest area, and (2) to provide a transition from a 160 foot center-to-center cross section (DeBorgia East and West) to the 60 foot center-to-center cross section recommended in this report.

B. CONNECTION TO DeBORGIA EAST AND WEST

The portion of Interstate I-90 investigated in this report begins at the easterly end of the DeBorgia East and West Project. At this point, the designed alignment is based on 160-foot centers. The alignment recommended in this report requires a transition to 60-foot centers within the first 2,745 feet. It is recommended that this transition be accomplished using a 2-degree, 45-minute curve for each lane. By offsetting the P.I.'s of these curves, the desired transition is smoothly achieved. In order to accomplish this transition, it is necessary to slightly modify the design on the DeBorgia East and West Project. This modification would extend for 1,000 feet into the DeBorgia Project in the form of a 1-degree horizontal curve on the westbound lane only. This curve would require a 3-degree, 59-minute, 54-second deflection in the bearing of the last 600 feet of the DeBorgia Project.

In addition to the foregoing, the Henderson interchange will require the following additions to the DeBorgia design: (1) the westbound entrance ramp will terminate 400 feet inside the DeBorgia design; (2) the eastbound exit ramp will begin 1,000 feet inside the DeBorgia design.

C. THE HENDERSON INTERCHANGE

This interchange provides access to Twelvemile road (Camel Hump road) and to a proposed rest area.

Review Comments & Notes

It is recommended the interstate be carried over the cross-road in order to save the stand of cottonwood trees lying south of the interchange. (See Photo No. 1, Appendix A.) Inasmuch as we recommend that a rest area be placed in the southwest quadrant of the interchange, it is important that the natural beauty be maintained as much as possible.

In taking the interstate over and maintaining the existing crossroad grade, the ramp grades fit the existing terrain very well. A cut is required by the ramp in the northwest quadrant at Station 110+00; however, it is believed this problem can be minimized in final design.

Separate structures are proposed for the eastbound and west bound lanes at the Henderson interchange. These structures will be almost identical with each having a 38-foot width between curbs and an over-all length of 140 feet giving a total deck area of 5,320 square feet.

The proposed structures shall consist of three equal simple spans of approximately 46 feet, 8 inches each with two interior pier bents. All piers, interior and end piers, will have skew angles of from eight degrees to ten degrees. The center span length of 46 feet, 8 inches will provide generous lateral clearance for the Twelvemile road below.

Three equal spans are desirable from an engineering standpoint since the design for all spans would be the same. In addition, with all spans equal, longitudinal load on the interior piers due to temperature change would be eliminated as a design factor which would effect a cost savings in the pier columns and foundations.

Proposed superstructure construction shall consist of a poured concrete deck slab on six equally spaced prestressed concrete stringers at approximately seven feet, seven inches on centers supported on double "T" head poured concrete pier bents. It is anticipated that the pier foundation will be spread footings because of the geological aspects of the area; however, this will have to be substantiated by borings at a later date.

D. REST AREA

The southwest quadrant of the interchange offers an excellent location for a rest area. Since the interchange is required at any rate, the cost of access to a rest area located elsewhere is eliminated. Signing for the rest area can be incorporated into interchange signing. The rest area will be located adjacent to the river and little or no additional landscaping will be required. Pedestrian traffic will be far removed from the interstate and the area is sufficiently large to provide safe and efficient traffic movements within the rest area.

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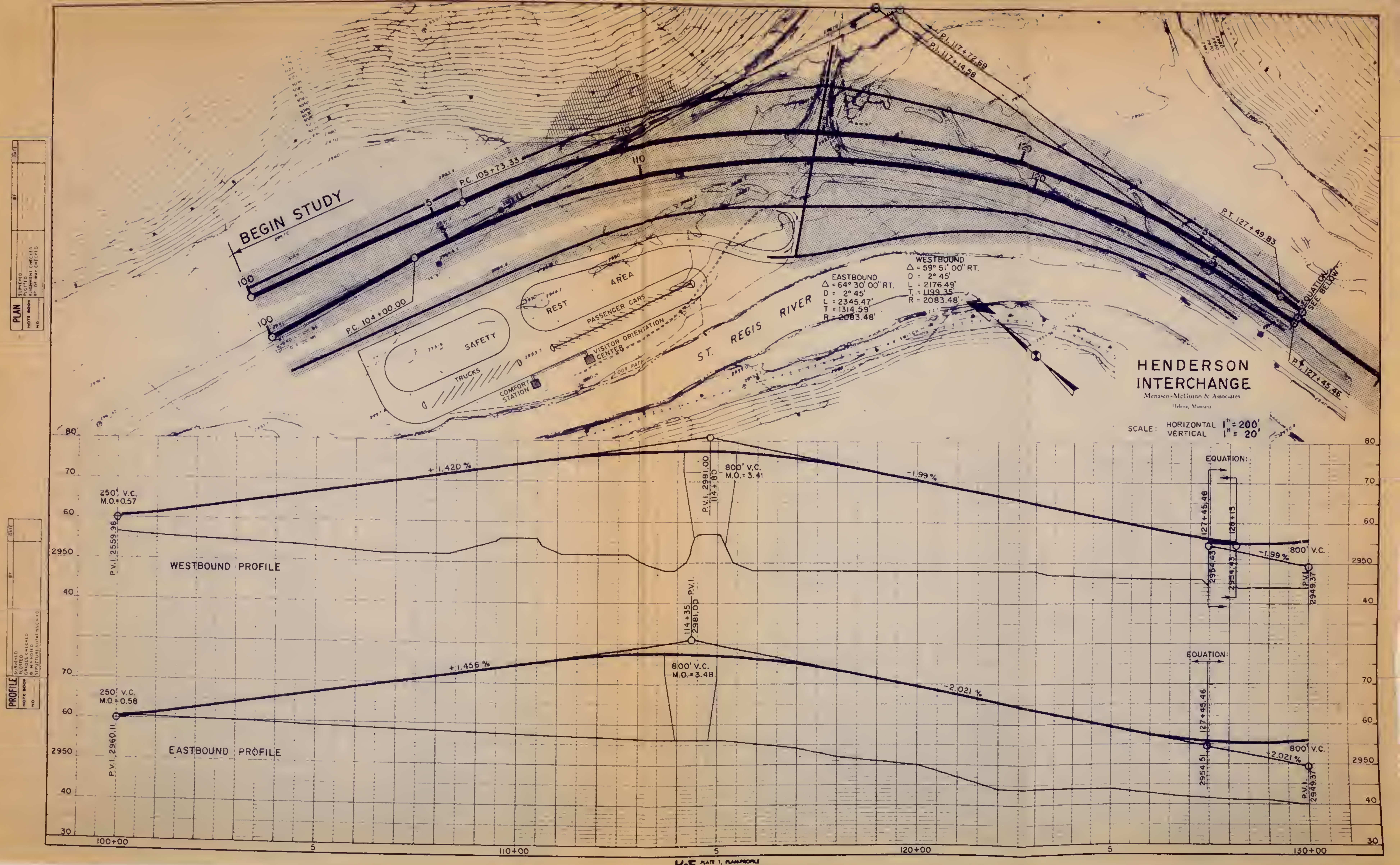
BEGIN STUDY
P.C. 105+73.33
P.C. 104+00.00
P.I. 117+72.69
P.I. 117+14.58
P.T. 127+49.83
P.T. 127+45.46
EQUATION SEE BELOW
SAFETY REST AREA
TRUCKS
PASSENGER CARS
COMFORT STATION
VISITOR ORIENTATION CENTER
ST. REGIS RIVER
EASTBOUND
Δ = 64° 30' 00" RT.
D = 2° 45'
L = 2345.47'
T = 1314.59'
R = 2083.48'
WESTBOUND
Δ = 59° 51' 00" RT.
D = 2° 45'
L = 2176.49'
T = 1199.35'
R = 2083.48'
HENDERSON INTERCHANGE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200' VERTICAL 1" = 20'
WESTBOUND PROFILE
250' V.C. M.O. = 0.57
P.V.I. 2959.98
+1.420 %
P.V.I. 2981.00 114+80
800' V.C. M.O. = 3.41
-1.99 %
EQUATION:
127+45.46
128+13
2954.43
2954.43
800' V.C.
P.V.I. 2949.37
EASTBOUND PROFILE
250' V.C. M.O. = 0.58
P.V.I. 2960.11
+1.456 %
114+35 2981.00 P.V.I.
800' V.C. M.O. = 3.48
-2.021 %
EQUATION:
127+45.46
2954.51
800' V.C.
P.V.I. 2949.37
100+00
110+00
120+00
130+00
PLAN
PROFILE
K+E PLATE 1, PLAN-PROFILE

Part III
“20” Line

P A R T I I I

"20" LINE

A. INTRODUCTION

The "20" Line was studied to arrive at a location with the best driver view, the least complicated construction, and the most river access. We positioned this roadway on the sidehill, high above the canyon floor to provide the above-mentioned features.

B. HORIZONTAL ALIGNMENT

The data for the horizontal alignment is shown in the data sheets following.

Beginning at Station 130+00, the "20" Line enters a 5-degree curve to the left to place the roadway up on the sidehill. At Station 150+18, another curve of 7 degrees to the left was introduced to negotiate a bend in the river. These two curves to the left could be connected by a long spiral to eliminate the "broken back" curve effect on final design. It should be noted that spirals have not been used in this study. It is our intention to use spirals on final design and tangents between curves have been established with sufficient length to introject these spirals. The "20" Line continues around the hillside using a 7-degree right curve at Station 174+70 and a 6-degree curve right at Station 191+11. Again, a long spiral will be used to connect these two curves to the right. One more curve is required to negotiate the 180-degree bend in the river. This curve is a 6-degree, 30-minute curve to the left. The downgrading of the "20" Line horizontal alignment is due to the preceding four curves.

After traversing the reversing bend in the river, the "20" Line is in a good location to take advantage of its hillside location which allows easing the curvature by cutting across noses and draws. A series of curves from Station 218+83 ahead through the Drexel interchange are as follows:

Station 225+32, a 7-degree curve left
Station 243+46, a 5-degree curve left
Station 259+91, a 7-degree, 15-minute curve right
Station 270+64, a 7-degree curve left
Station 287+22, a 6-degree curve right
Station 298+66, a 6-degree curve left

The last curve above leads into the tangent for the Drexel interchange area.

Review Comments & Notes

From the Drexel interchange ahead to the east end of the project, the topography and the river meanderings limit the opportunity for a sidehill location. Consequently, the horizontal alignment is parallel to the PTW. The maximum degree curve occurs at Station 357+57 with a 7-degree, 30-minute curve to the left. The horizontal placement of this curve was established by studying the requirement of "on" and "off" ramps for the Ward Creek access. Future detailed design may ease this curve somewhat.

Ahead, a 6 - degree curve to the right at Station 337+29 leads into a 1,100-foot tangent followed by a 4-degree curve to the right. The latter curve is followed by an 1,800-foot tangent to the end of the project.

As mentioned earlier, the problem area for the "20" Line horizontal alignment occurs between Station 150 + 00 through Station 208+00. The "21", "22" and "23" alignments have relieved this problem area by the use of structures which allow the alignments to "cut across" and, in turn, reduce the total delta angle of the series of curves.

C. VERTICAL ALIGNMENT

Beginning at Station 130 + 00, the roadway starts a +5.19 percent grade to climb to the sidehill location. At Station 150+00, care was taken to place a long (1,800 feet) vertical curve due to the 7-degree horizontal curve at this same location. The placement of a steep horizontal and a steep vertical curve at the same location can render an alignment unacceptable. Once the ridge at Station 155+00 has been crossed at an elevation of 3,082 feet, the vertical alignment gradually decends by the use of rolling grades to Station 273+00. In this area, care again was taken to insure compatibility between horizontal and vertical alignments. Slight adjustments to these grades will be necessary during final design to better balance earthwork and to control fill and cut slopes. At Station 273+00, a -3.99 percent grade is proposed to bring the roadway down from its sidehill location into the Drexel interchange area.

The grade is held down through the interchange area to allow the crossroad to be brought over the interstate. The ramp grades on the north side of the roadway, in climbing to match the crossroad grade, fit well on the sidehill. The two south ramps will be built on fill.

From the Drexel interchange to the east end of the project, the vertical alignment parallels the PTW grade with one exception. The exception is at Station 356 + 50 where the grade was raised to cross the nose at this station and allow the ramps to be taken off for the Ward Creek access.

Review Comments & Notes

D. ROADWAY CROSS SECTION

Template A, as shown in all comparisons, is a cross section having a 34-foot center-to-center, 10-foot median with a median guard rail for the entire length of the project.

The drawings included in this Part III indicate Template B and reflect cuts and fills for a combination of 60-foot center-to-center cross section and portions of 34-foot centers.

From Station 130 + 00 to the Drexel interchange, the cross section has 60-foot centers. From the Drexel interchange to the east end of the project, 34-foot centers have been proposed. The "20" Line B Template has 60.88 percent of roadway with the wider median. This is the greatest percentage of wide median of all lines studied.

E. ANNUAL COST

The "20" Line A Template has the lowest construction costs of all lines studied, which is $3,936,821. The B Template is next with $4,421,848. The operating annual costs for both templates are the same and amount to $1,165,704. Total annual costs for the "20" Line A Template are $1,479,899 and for the B Template, are $1,508,450.

Estimating procedures are as outlined in Part I-I.

F. RIVER ACCESS AND CONFLICT

As mentioned in the "Introduction", the "20" Line was conceived to allow as much river access as possible and to conflict with the river as little as possible. The "20" Line, as indicated on the following plans, provides access to the river from Henderson to Drexel with only minor rebuilding of the PTW (0.627 miles).

Between Henderson and Drexel, there is 1,000 feet of minor river conflict requiring no retaining walls or channel changing. The one area of major river conflict is at the Ward Creek access where the ramps on the eastbound roadway will require 1,410 feet of major retaining walls to retain the present river location.

G. MAINTENANCE

The "20" Line has 9.08 percent wide median on the A Template, which is an indication of the snow storage capacity. The B Template is 60.88 percent wide median.

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Both templates have comparable amounts of rock cut ditches from which rock removal will be required. This length of ditch is about 14,850 linear feet. Structures requiring sanding amount to 1,940 linear feet. The length of roadway over 3 percent which will require additional sanding amounts to 7,241 linear feet.

The cost of pavement maintenance is covered under Section E, "Annual Cost".

H. CONSTRUCTION METHODS

The "20" Line, due to its small amount of bridges (530 linear feet) and retaining walls (1,410 linear feet), is the least complicated line to construct.

The "20" Line also provides 4.128 miles of PTW that can be used as a separate detour. This line requires all traffic to be routed through the construction area for a distance of 2.493 miles.

The "20" Line will have balanced earthwork throughout. The haul distances can be held to a minimum. The total excavation for Template A is 3,207,125 cubic yards, and 4,140,481 cubic yards for Template B.

I. SCENIC EVALUATION

The "20" Line, due to its elevated location, will afford the driver a view of the entire canyon. Photos No. 4 and No. 5 of Appendix A reflect the view available to a driver negotiating the "20" Line, while Photo No. 2 of Appendix A shows a view from the canyon floor.

J. UTILITIES

The "20" Line does not conflict with the power line owned by the Milwaukee Railroad. There will also be no conflict with the railroad right-of-way.

This line will require 209 poles of the trunk telephone line to be relocated. The opportunity to relocate any utility along the existing PTW from Henderson to Drexel is provided by the "20" Line.

K. DESIGN STANDARDS

Design standards for the "20" Line are as discussed in Part I-C.

Review Comments & Notes

L. TRAFFIC

The "20" Line traffic is as discussed in Part I-E of this report.

M. RIGHT-OF-WAY

Three private ownerships will require right-of-way "take". These "takes" and their acreages are as follows:

Henderson, 20.6 acres from the DeCoursey property.
Station 225+00, 23 acres from the Mayo property.
Drexel, 37 acres from the Knowles property.
Station 390+00, one acre from the State of Montana.

The remainder of the "take" will be from the United States Government and will amount to 86 acres. The total "take" for this line will be 177.2 acres.

N. STRUCTURES

The only structures required for the "20" Line are those at the Henderson interchange and the Drexel interchange. These structures are considered standard type structures and were estimated at $12.00 per square foot.

(1) Henderson Interchange

Refer to Part II - Henderson Interchange.

(2) Drexel Interchange

At this location of the Drexel access road over I-90, the proposed structure has a width between curbs of 32 feet and a length of 160 feet which gives a total deck area of 5,120 square feet. The cost data sheets show this structure to be 250 feet long with a total deck area of 8,000 square feet. Additional studies made since the cost estimate was prepared indicated this structure could be shortened to 160 feet. It is here so presented.

The structure shall consist of four approximately equal simple spans of 40 feet each. The piers will be set normal to the axis of the bridge and will therefore have zero skew. The center pier will be located on the centerline of the median of I-90 and the adjacent piers at either side of center will be located at the edge of shoulder. The fact that this structure has equal spans, as in the case of the Henderson interchange bridges, will again simplify the design since the analysis would be confined to only one span.

Review Comments & Notes

The superstructure, as for the Henderson interchange structures, would consist of a poured concrete deck slab on prestressed concrete stringers. The stringer spacing here, however, will be predicated on the use of five stringers giving a spacing of approximately seven feet. The piers will be double "T head" type, again similar to those proposed for the Henderson interchange structures. Spread footing foundations would again probably be suitable for this structure.

O. GEOLOGY

The geology for the "20" Line is as stated in Part I-H.

P. DRAINAGE

At Station 134 + 00, a double 15' x 9' box culvert will be required to drain Twelvemile Creek. This is the largest single drainage area along the project and constitutes approximately 40,000 acres.

At Station 176+00, 215 acres of drainage will require 180 feet of 36-inch drain pipe to carry the water across the alignment which is in a low fill. A field cast bend with a reducer and 120 feet of 24-inch drain pipe will then carry the water down the fill slope to the river.

Five-hundred-twelve (512) acres are trapped at Station 190+50 by a fill section. This drainage will require 200 feet of 48-inch drain pipe to carry the water across the roadway. A field cast bend with a reducer and 100 feet of 30-inch drain pipe will carry the water down the fill slope to the river.

At Station 217+00, 80 acres will be drained by 370 feet of 24-inch drain pipe.

A drainage of 50 acres is intercepted at Station 233+00 and 360 feet of 24-inch drain pipe will be required to handle this water.

At Station 258+00, a gulch with 620 acres of drainage will require 250 feet of 54-inch drain pipe to carry the water across the roadway. A field cast bend with a reducer and 185 feet of 36-inch drain pipe will carry the water down the fill slope.

At Station 275+50, 90 acres are to be drained with 400 feet of 24-inch drain pipe and a field cast bend.

Five - hundred - six (506) acres at Station 290 + 00 will be drained by 142 feet of 48-inch drain pipe across the roadway. A

Review Comments & Notes

field cast bend with a reducer and 140 feet of 30-inch drain pipe will carry the water down the fill slope.

At Station 314 + 00, 244 feet of 24 - inch drain pipe will drain a small drainage area on the left. At Station 335 + 00, a sag vertical curve requires 146 feet of 30-inch drain pipe.

At Stations 332+00 and 352+00, small natural drainages occur through short sections of fill. One-hundred-seventy (170) feet and 205 feet respectively of 24-inch drain pipe and one inlet each will be required at these locations.

Between Stations 366+00 and 370+00, 314 acres drain toward the proposed highway. For this estimate, a 400 linear foot interceptor ditch was used above the top of cut line from Station 366+00 to an inlet at Station 370+00. This inlet is connected to an inlet in the left roadway cut ditch by 200 feet of 30-inch drain pipe. The water then crosses I-90 to the river through 144 feet of 42-inch drain pipe.

At Station 388 + 00, another natural drainage is undercut. This gulch drains 760 acres. Therefore, for slope protection, flow is intercepted with an inlet in the undisturbed channel. This inlet is connected to an inlet in the left roadway ditch by 60 feet of 36 - inch drain pipe. The water then crosses I-90 through 144 feet of 54-inch drain pipe.

Q. HIGHWAY RATING INDEX

The summary section of this report gives a tabular comparison of all items evaluated to develop the rating index. The following pages include all the data used in the nine individual comparisons.

Review Comments & Notes

HORIZONTAL ALIGNMENT - "20" LINE

Comparison Items	Amount	Points
Total Length of Comparison:		
Feet.	30,644.55'	
Miles	5.804	4
Total Number of Curves	19	
Curve Frequency Per Mile	3.27	6
Maximum Degree of Curvature.	7.50°	6
Average Degree of Curvature.	6.18°	5
Average Length of Curve.	848.52'	4
Average Deflection Per Curve	50.80°	4
Total Deflection Over Comparison	965.27°	4
Average Deflection Per Mile.	166.31°	4
Total Feet Curvilinear Roadway	16,121.90'	4
Percent of Curvilinear Roadway	52.6%	4
Average Tangent Between Curves	679.87'	4
Total Number of Structures	4	10
TOTAL POINTS.		59

Review Comments & Notes

HORIZONTAL ALIGNMENT DATA - "20" LINE

Curve Number	Deflection Angle	Degree of Curve	Length	Distance P.C. to P.T.
1*	62.18°	2.75°	2,260.98'	
				638.07'
2	37.98°	5.00°	759.66'	
				875.28'
3	90.39°	7.00°	1,291.33'	
				296.33'
4	93.14°	7.00°	1,330.53'	
				686.98'
5	54.14°	6.00°	902.40'	
				293.43'
6	65.10°	6.50°	1,001.53'	
				336.62'
7	54.42°	7.50°	725.60'	
				305.69'
8	45.51°	7.00°	650.14'	
				1,151.23'
9	34.53°	5.00°	690.56'	
				805.59'
10	65.19°	7.25°	899.18'	
				248.16'
11	55.57°	7.00°	793.83'	
				644.45'
12	68.55°	6.00°	1,142.57'	
				285.94'
13	41.90°	6.00°	698.41'	
				1,181.92'
14	26.48°	7.00°	378.22'	
				849.68'
15	49.52°	6.00°	825.27'	
				1,170.44'
16	24.66°	7.00°	352.31'	
				331.47'
17	63.16°	7.50°	842.34'	
				1,011.66'
18	22.26°	6.00°	370.95'	
				1,124.67'
19	8.25°	4.00°	206.20'	
Total	967.27°	117.50°	16,121.90'	12,917.53'
Average	50.08°	6.18°	848.52'	679.87'

Percent Curvilinear Roadway = $\frac{16,121.90}{30,644.55}$ = 52.6%

Average Deflection Per Mile = $\frac{967.27}{5.804}$ = 166.31°

* Henderson Interchange Area.

Review Comments & Notes

VERTICAL ALIGNMENT - "20" LINE

Comparison Items	Amount	Points
Total Length of Comparison:		
Feet.	30,644.55'	
Miles	5.804	4
Total Number of Vertical Curves.	13	
Curve Frequency Per Mile	2.24	6
Average Length of Vertical Curve	876.90'	
Average Algebraic Difference	4.020%	
K Factor(1).	218.13	2
Maximum Grade in Comparison.	5.194%	5
Average Grade in Comparison.	2.178%	4
Percentage of Roadway with:		
5% Grade or More.	9.5%	4
3% - 5% Grade	12.4%	10
2% - 3% Grade	39.6%	2
Less than 2% Grade.	38.5%	2
TOTAL POINTS.		39

(1) K = Average length of vertical curve divided by average algebraic difference.

Review Comments & Notes

VERTICAL ALIGNMENT DATA - "20" LINE

Sta. VPI	Distance VPI-VPI	Per Cent Grade	G2-G1	Length V.C.	K Factor
100+00					
	1,457.5'	+1.438%			
114+57.5			3.444	800'	232
	1,542.5'	-2.006%			
130+00			7.200	800'	111
	2,900'	+5.194%			
159+00			8.033	1,800'	224
	3,100'	-2.839%			
190+00			4.224	800'	189
	1,300'	+1.385%			
203+00			4.462	1,400'	313
	1,300'	-3.077%			
216+00			2.521	600'	238
	1,800'	-0.556%			
234+00			2.904	800'	275
	1,300'	+1.538%			
247+00			3.538	800'	238
	2,600'	-2.000%			
273+00			1.990	800'	402
	2,500'	-3.990%			
298+00			3.173	800'	252
	3,700'	-0.817%			
335+00			3.329	400'	120
	2,150'	+2.512%			
356+50			5.203	1,200'	230
	2,750'	-2.691%			
384+00			2.245	400'	178
	2,244.5'	-0.446%			
406+44.5					
Total		30.492%	52.260	11,400'	2835.69
Average		2.178%	4.020	876.92'	218.13

Review Comments & Notes

ROADWAY CROSS SECTION - "20" LINE

Comparison Items	Template A Amount	Template A Points	Template B Amount	Template B Points
34' Center-Center, Miles . . .	5.277		2.273	
60' Center-Center, Miles . . .	0.527		3.538	
34' Center-Center.	90.92%	2	39.12%	14
60' Center-Center.	9.08%	2	60.88%	14
TOTAL POINTS.		4		28

Review Comments & Notes

ROADWAY CROSS SECTION DATA - "20" LINE

	34' Center-Center (Miles)	60' Center-Center (Miles)
Template A:		
*100+00 to 127+45.46		0.527
127+45.46 to 406+44.55	5.277	
Total	5.277	0.527
Per Cent	90.92%	9.08%
Template B:		
*100+00 to 127+45.46		0.527
127+45.46 to 280+71.86		2.903
280+71.86 to 292+14.43 (Transition)	0.108	0.108
292+14.43 to 406+44.55	2.165	
Total	2.273	3.538
Per Cent	39.12%	60.88%

* Henderson Interchange

Review Comments & Notes

COST ESTIMATE - "20" LINE

	CAPITAL RECOVERY FACTOR		TEMPLATE A 34' Ctr-Ctr Only		TEMPLATE B 34' Ctr-Ctr & 60' Ctr-Ctr	
	Years	Interest	Const. Cost	Annual Cost	Const. Cost	Annual Cost
Guard Rail	20	0.0872	$ 339,720	$ 29,618	$ 216,511	$ 18,876
Base, Surfacing & Pavement	20	0.0872	1,097,361	95,673	1,106,881	96,503
Grading, Earthwork & Channel Change	40	0.0665	1,924,201	127,885	2,484,289	165,110
Drainage	40	0.0665	181,250	12,046	219,878	13,284
Retaining Walls	50	0.0634	84,600	5,367	84,600	5,367
Major Structures	50	0.0634	127,680	8,101	127,680	8,101
Cantilever Section	50	0.0634	-0-	-0-	-0-	-0-
Utilities	50	0.0634	104,500	6,630	104,500	6,630
Rest Area	20	0.0872	28,685	2,500	28,685	2,500
Traffic Control	20	0.0872	48,824	4,256	48,824	4,256
TOTAL CONSTRUCTION COST			$3,936,821		$4,421,848	
Sub-Total Annual Cost				$ 292,076		$ 320,627
Percentage of Construction Cost Differential			100.0%		112.5%	
Maintenance:						
Interstate 4-Lane @ $3,000/Mile				17,430		17,430
Crossroad & Interchange Ramps @ $1,500/Mile				4,689		4,689
Operating Cost				1,165,704		1,165,704
TOTAL ANNUAL COST				$1,479,899		$1,508,450

RIVER ACCESS & CONFLICT - "20" LINE

Comparison Items	Amount	Points
Total River Access, Miles.	4.128	8
Percent of Present Access Retained	71%	8
Present Access Road (PTW) Relocated, Miles	0.627	4
Minor River Conflict, Feet[(1)]	1,000'	10
Major River Conflict, Feet[(2)]	1,410'	9
River Improvement[(3)]	None	5
River Access Continuous Between Henderson and Drexel.	Yes	8
TOTAL POINTS.		52

(1) Encroachment on present river bed not requiring channel change or retaining wall.

(2) Encroachment on present river bed requiring undesirable channel change or retaining wall.

(3) Desirable channel change, flood plain improvement, etc.

Review Comments & Notes

RIVER ACCESS & CONFLICT DATA

"20" LINE, TEMPLATE B

Items	1	(b) 2	3	4	5
(a) PTW Stations	Amt. River Access	Percent Access Main-tained	Total Constr. Items 1 & 2	Amt. Minor Conflict	Amt. Major Conflict
Henderson Interchange	2,696'	8.78%			
0+00 to 65+00	6,500'	21.17%			
65+00 to 81+00	1,600'	5.21%	1,600'		
81+00 to 100+00	1,900'	6.19%			
100+00 to 108+50	850'	2.77%	850'		
108+50 to 125+00	1,650'	5.37%			
125+00 to 128+30	330'	1.07%	330'		
128+30 to 144+70	1,640'	5.34%			
144+70 to 150+00	530'	1.73%	530'		
150+00 to 191+00	4,100'	13.36%			
Beyond Drexel	0'	0.00%		1,000'	1,410'
Total Feet	21,796'	71.00%	3,310'	1,000'	1,410'
Total Miles	4.128	71.00%	0.627		

(a) 127+45 I-90 = 0+00 PTW (Comparison Equation Only).

(b) Present access is approximately 5.81 miles.

Review Comments & Notes

MAINTENANCE - "20" LINE

Comparison Items	Template A Amount	Template A Points	Template B Amount	Template B Points
Snow Removal:				
Percent of Roadway with Depressed Median.	9.08%	2	60.88%	14
Rock Removal:				
Linear Feet of Cut Ditch	14,850'	12	15,790'	6
Structure Maintenance:				
Linear Feet of Structures.	1,940'	15	1,940'	15
Sanding:				
Linear Feet of Problem Roadway	7,241'	11	7,241'	11
TOTAL POINTS.		40		46

PART III - Table 10

Review Comments & Notes

MAINTENANCE DATA - "20" LINE

SNOW REMOVAL

$$\frac{\text{Total Miles of Depressed Median}}{\text{Total Length of "20" Line}} = \frac{3.538}{5.804} = 60.88\%$$

ROCK REMOVAL

Location	Cut Ditch (Lin. Ft.)
109+00 to 111+30	230'
134+60 to 148+80	1,420'
153+00 to 162+80, Rt & Lt	1,960'
182+00 to 185+00	300'
194+50 to 205+75	1,125'
205+75 to 210+00	425'
221+00 to 245+00, + 900' Rt	3,100'
245+00 to 258+30	1,330'
262+00 to 270+00, Rt & Lt	1,600'
284+00 to 296+00	1,200'
315+00 to 326+50	1,150'
346+00 to 358+50	1,250'
369+00 to 376+00	700'
TOTAL	15,790'

STRUCTURE MAINTENANCE

Total Linear Feet of Major Structures	530'
Total Linear Feet of Retaining Wall	1,410'
TOTAL Linear Feet Structure Maintenance	1,940'

SANDING

Total Linear Feet of Roadway with 3% Grade or More	6,711.12'
Total Linear Feet of Bridge Deck	530.00'
TOTAL Feet of Problem Roadway	7,241.12'

Review Comments & Notes

CONSTRUCTION METHODS - "20" LINE

Comparison Items	Amount	Points
Traffic Control.		6
Earthwork Balance.		10
Simplicity		10
TOTAL POINTS		26

TRAFFIC CONTROL

(Miles)		
Length of Detour Comprised of PTW.	4.128	8
Length of Detour to be Constructed	2.493	6
Length of Detour Separated from Construction	4.128	8
Length of Detour on or Adjacent to Construction	2.493	6
TOTAL POINTS		28

EARTHWORK BALANCE

Does the Total Earthwork Balance?.	Yes	8
Total Number of Balance Points	10	10
Average Distance Between Balance Points (Miles)	0.528	10
TOTAL POINTS		28

SIMPLICITY

Total Linear Feet Major Structures	530'	10
Total Linear Feet Retaining Wall	1,410'	9
TOTAL POINTS		19

Review Comments & Notes

CONSTRUCTION METHODS DATA

SIMPLICITY - "20" LINE

MAJOR STRUCTURE DATA

Location	Length	Width	Deck Area (Sq.Ft.)
Henderson Interchange, Eastbound.	140'	38'	5,320
Henderson Interchange, Westbound.	140'	38'	5,320
Drexel Interchange, Crossroad.	250'	32'	8,000
TOTAL	530'		18,640

RETAINING WALL DATA

Location	Linear Feet
346+50 to 355+00.	850'
361+00 to 366+60.	560'
TOTAL.	1,410'

Review Comments & Notes

SCENIC EVALUATION - "20" LINE

Comparison Items	Template A Amount	Template A Points	Template B Amount	Template B Points
Panorama	*	8	*	14
Total Area Cut Faces (Square Yards).	298,169	12	372,711	2
Number of Areas Where View is Enhanced Over a High Fill.	4	13	4	13
TOTAL POINTS.		33		29

* Value judgment based upon field survey; see Scenic "Basis of Evaluation".

Review Comments & Notes

SCENIC EVALUATION DATA - "20" LINE

Location	Cut Face (Sq.Yd.)
109+00 to 111+30	3,644
134+60 to 148+80	34,755
153+00 to 162+80, Rt & Lt.	36,089
169+20 to 175+00	6,578
182+00 to 185+00	18,356
194+50 to 205+75	21,644
205+75 to 210+00	11,911
221+00 to 245+00, + 900' Rt.	69,778
245+00 to 258+30	27,822
262+00 to 270+00, Rt & Lt.	29,067
284+00 to 296+00	28,755
315+00 to 326+50	24,311
346+00 to 358+50	26,667
369+00 to 376+00	21,778
376+00 to 406+44.45.	11,555
TOTAL	372,711

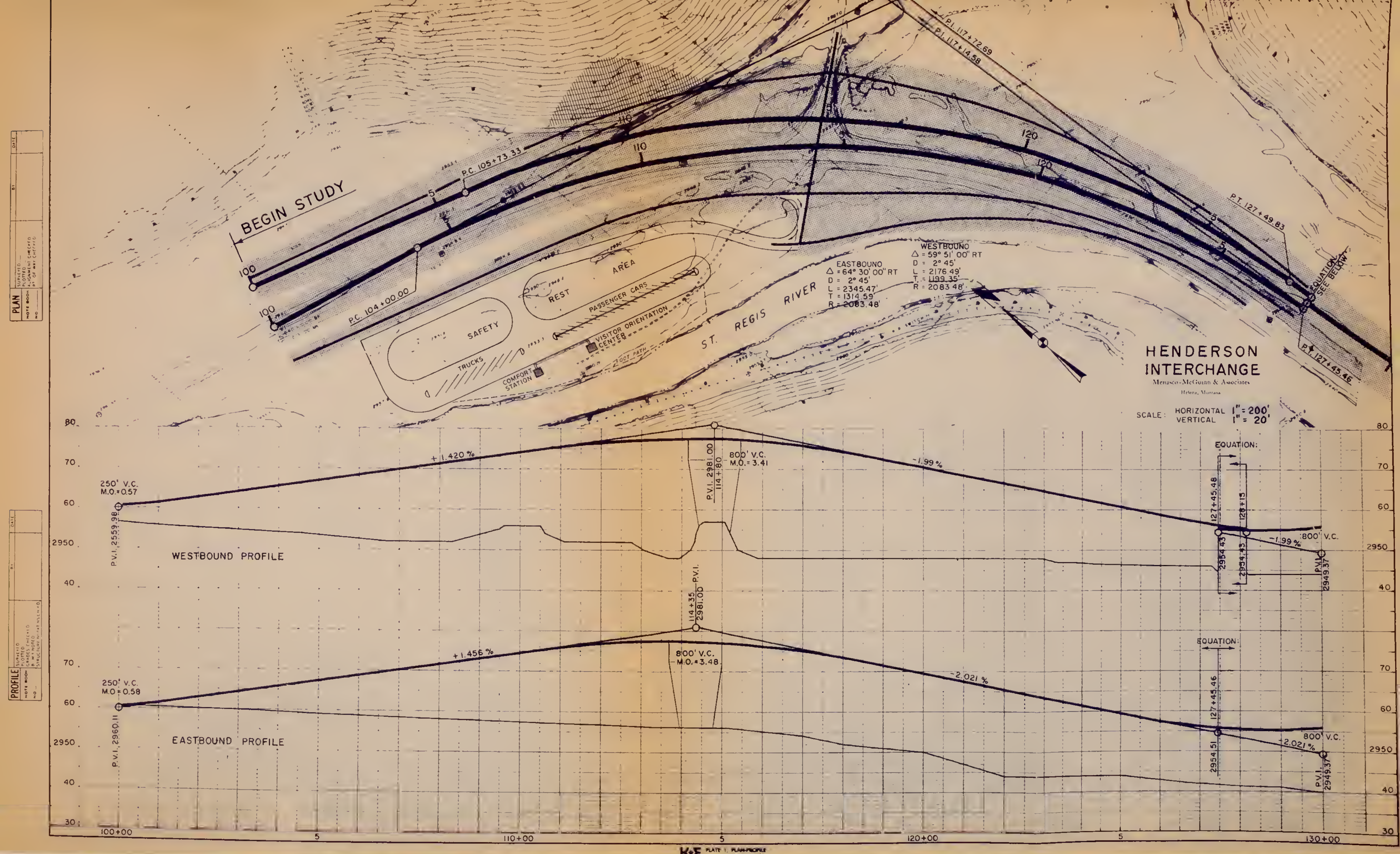
Review Comments & Notes

UTILITIES - "20" LINE

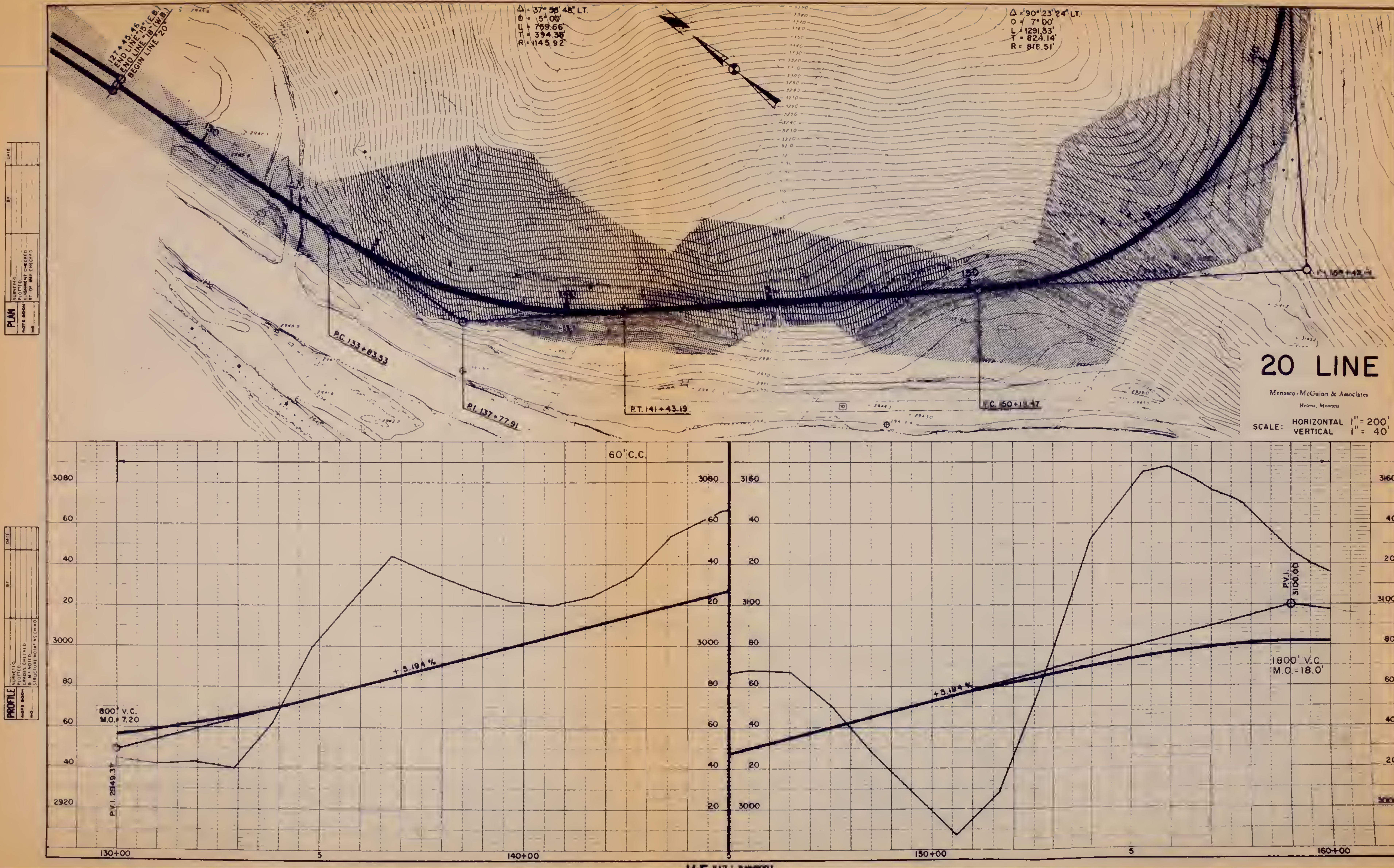
Comparison Item	Points
Versatility of Location*	6

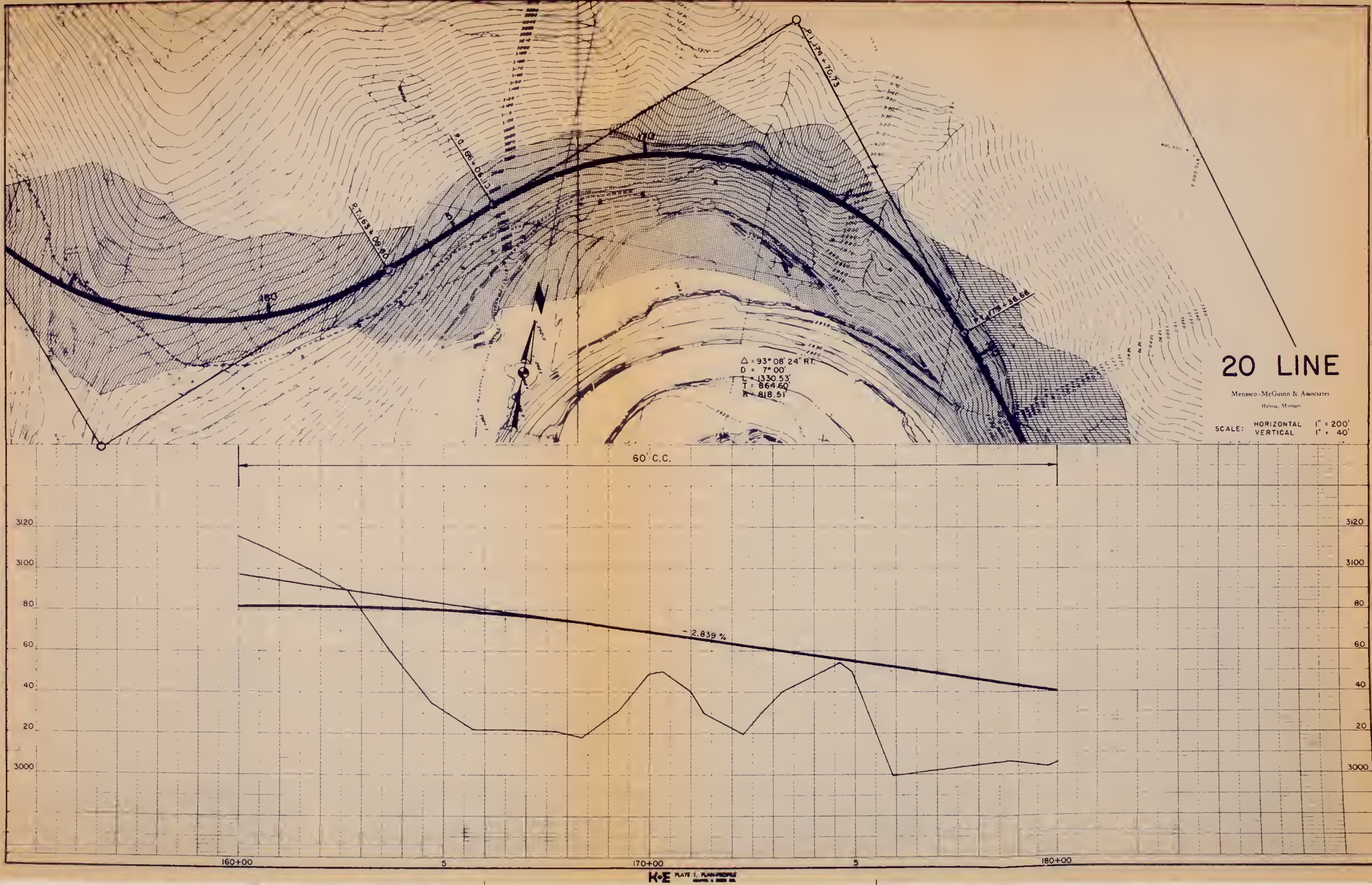
* For explanation of how points were assigned, see "Basis of Evaluation".

Review Comments & Notes

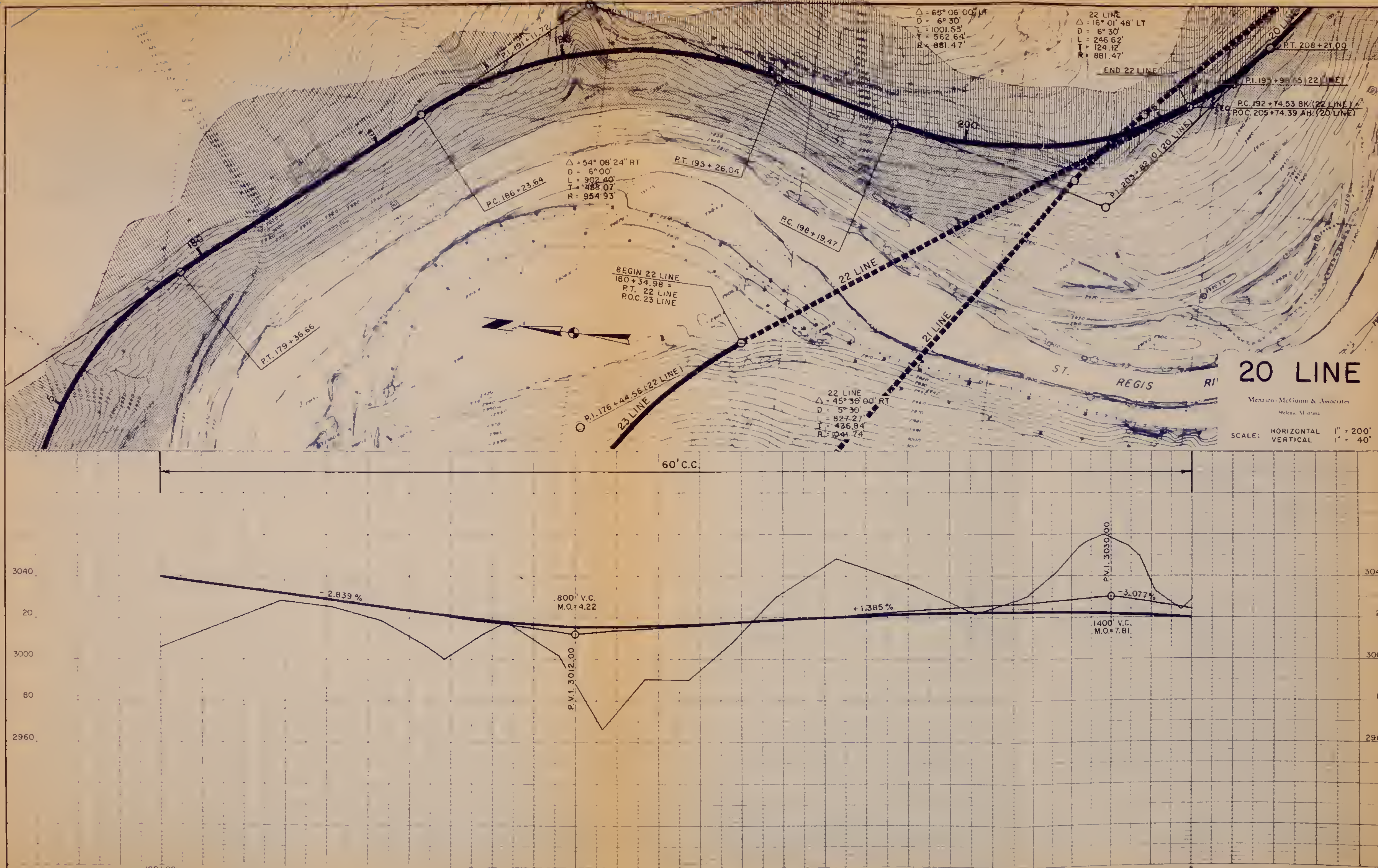


BEGIN STUDY
P.C. 105+73.33
P.C. 104+00.00
P.I. 117+72.69
P.I. 117+14.58
P.T. 127+49.83
P.T. 127+45.46
EQUATION SEE BELOW
REST AREA
SAFETY
TRUCKS
PASSENGER CARS
VISITOR ORIENTATION CENTER
COMFORT STATION
FOOT PATH
ST. REGIS RIVER
EASTBOUND
Δ = 64° 30' 00" RT
D = 2° 45'
L = 2345.47'
T = 1314.59'
R = 2083.48'
WESTBOUND
Δ = 59° 51' 00" RT
D = 2° 45'
L = 2176.49'
T = 1199.35'
R = 2083.48'
HENDERSON INTERCHANGE
Morrison-Maierle & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 20'
WESTBOUND PROFILE
250' V.C.
M.O. = 0.57
P.V.I. 2959.98
+1.420 %
P.V.I. 2981.00
114+80
800' V.C.
M.O. = 3.41
-1.99 %
EQUATION:
127+45.48
128+15
2954.43
2954.43
800' V.C.
P.V.I. 2949.37
EASTBOUND PROFILE
250' V.C.
M.O. = 0.58
P.V.I. 2960.11
+1.456 %
114+35
2981.00
P.V.I.
800' V.C.
M.O. = 3.48
-2.021 %
EQUATION:
127+45.46
2954.51
800' V.C.
-2.021 %
P.V.I. 2949.37
100+00
110+00
120+00
130+00
PLAN
PROFILE
K+E PLATE 1 PLAN-PROFILE


127+43.46
END LINE "15" (E.B.)
END LINE "18" (W.B.)
BEGIN LINE "20"
Δ = 37° 58' 48" LT.
D = 5° 00'
L = 759.66'
T = 394.38'
R = 1145.92'
Δ = 90° 23' 24" LT.
D = 7° 00'
L = 1291.33'
T = 824.14'
R = 818.51'
P.C. 133+83.53
P.I. 137+77.91
P.T. 141+43.19
P.C. 150+18.47
20 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
PLAN
PROFILE
60' C.C.
800' V.C.
M.O. = 7.20
P.V.I. 2949.37
+ 5.194 %
+ 5.194 %
1800' V.C.
M.O. = 18.0'
P.V.I. 3100.00
3080
60
40
20
3000
80
60
40
2920
3160
40
20
3100
80
60
40
20
3000
130+00
5
140+00
5
150+00
5
160+00
K+E PLATE 1 PLAN-PROFILE



P.T. 163+09.60
P.C. 166+06.13
P.I. 174+70.73
P.T. 179+36.66
△ = 93° 08' 24" RT.
D = 7° 00'
L = 1330.53'
T = 864.60'
R = 818.51'
20 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
PLAN
PROFILE
60' C.C.
-2.839 %
3120
3100
80
60
40
20
3000
160+00
5
170+00
5
180+00
K+E PLATE 1, PLAN-PROFILE

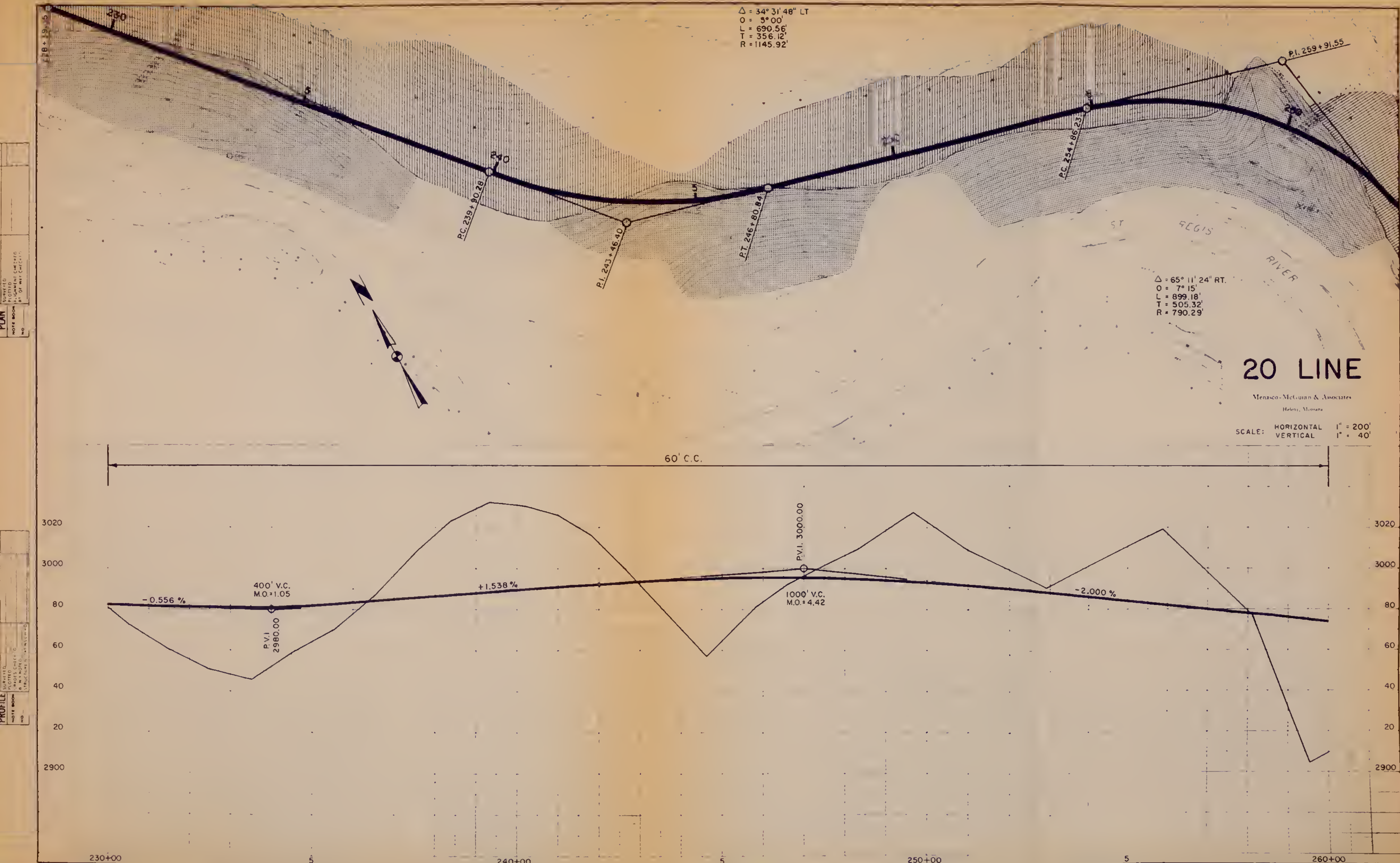


PLAN
NOTE BOOK
NO.
SURVEYED
PLOTTED
ALIGNMENT CHECKED
R/W CHECKED
BY
DATE

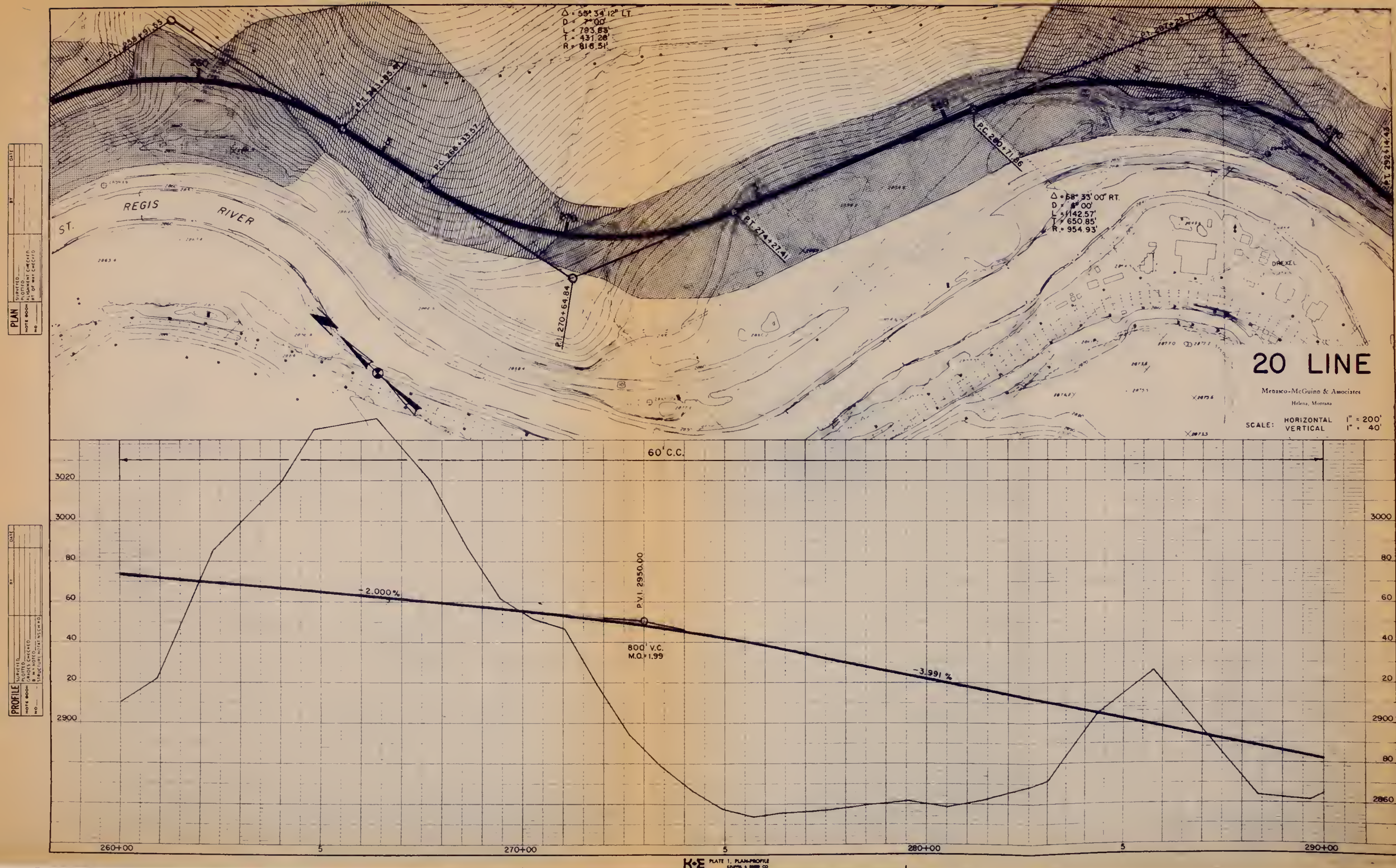
PROFILE
NOTE BOOK
NO.
SURVEYED
PLOTTED
GRADES CHECKED
B.M. NOTED
STRUCTURE NOTATIONS
BY
DATE

K+E PLATE 1, PLAN-PROFILE

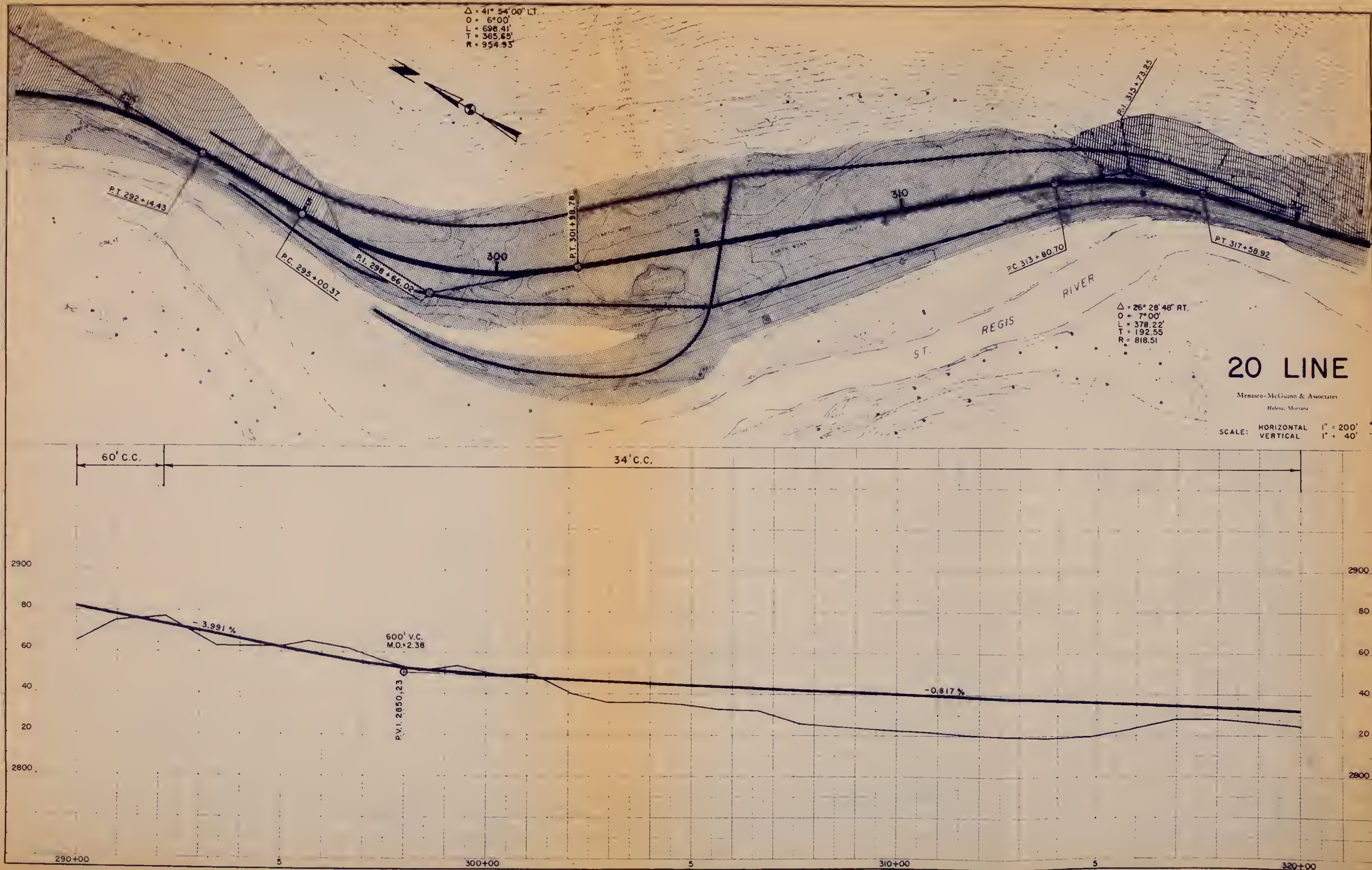
K+E PLATE 1. PLAN-PROFILE



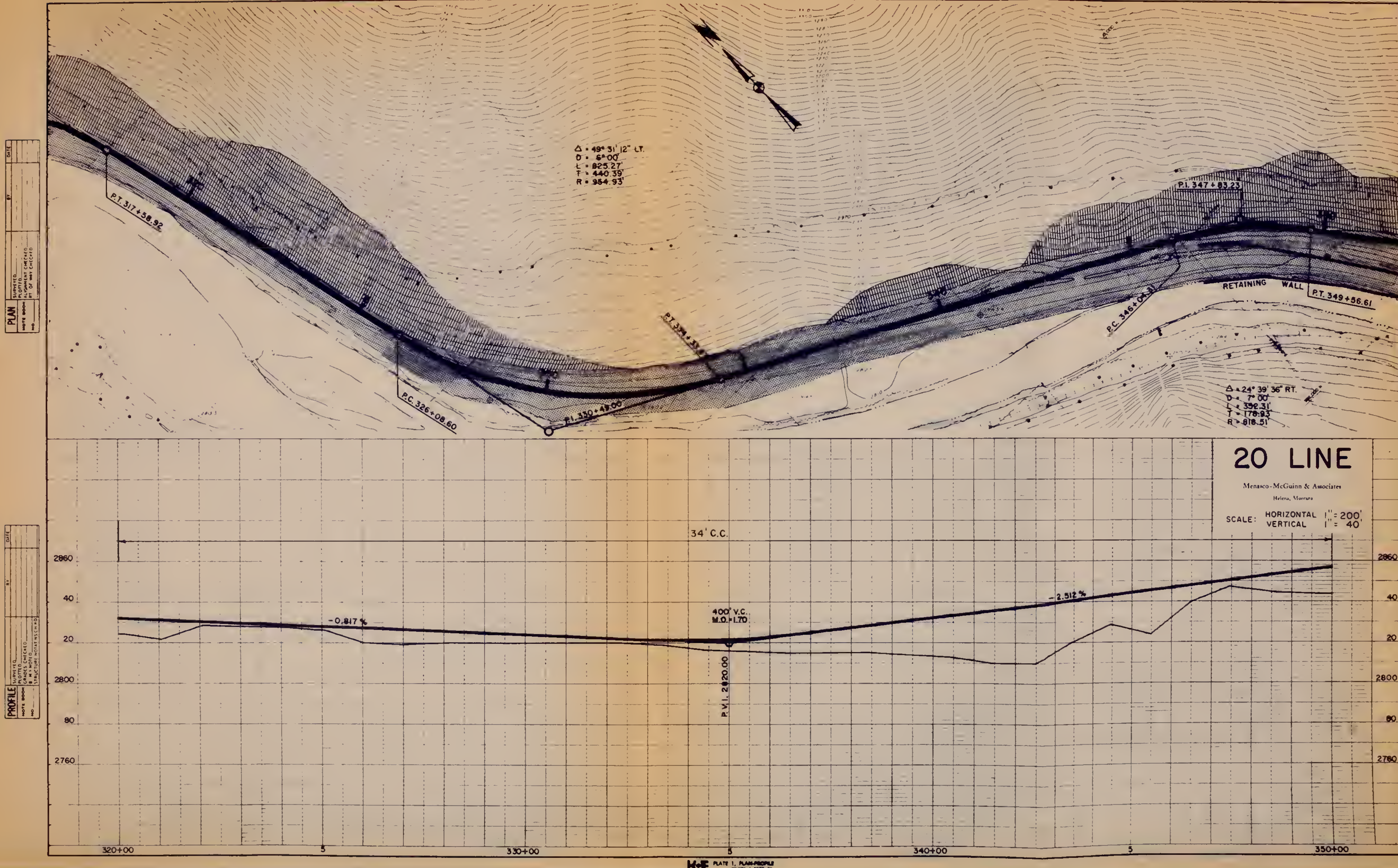
K+E PLATE 1. PLAN-PROFILE



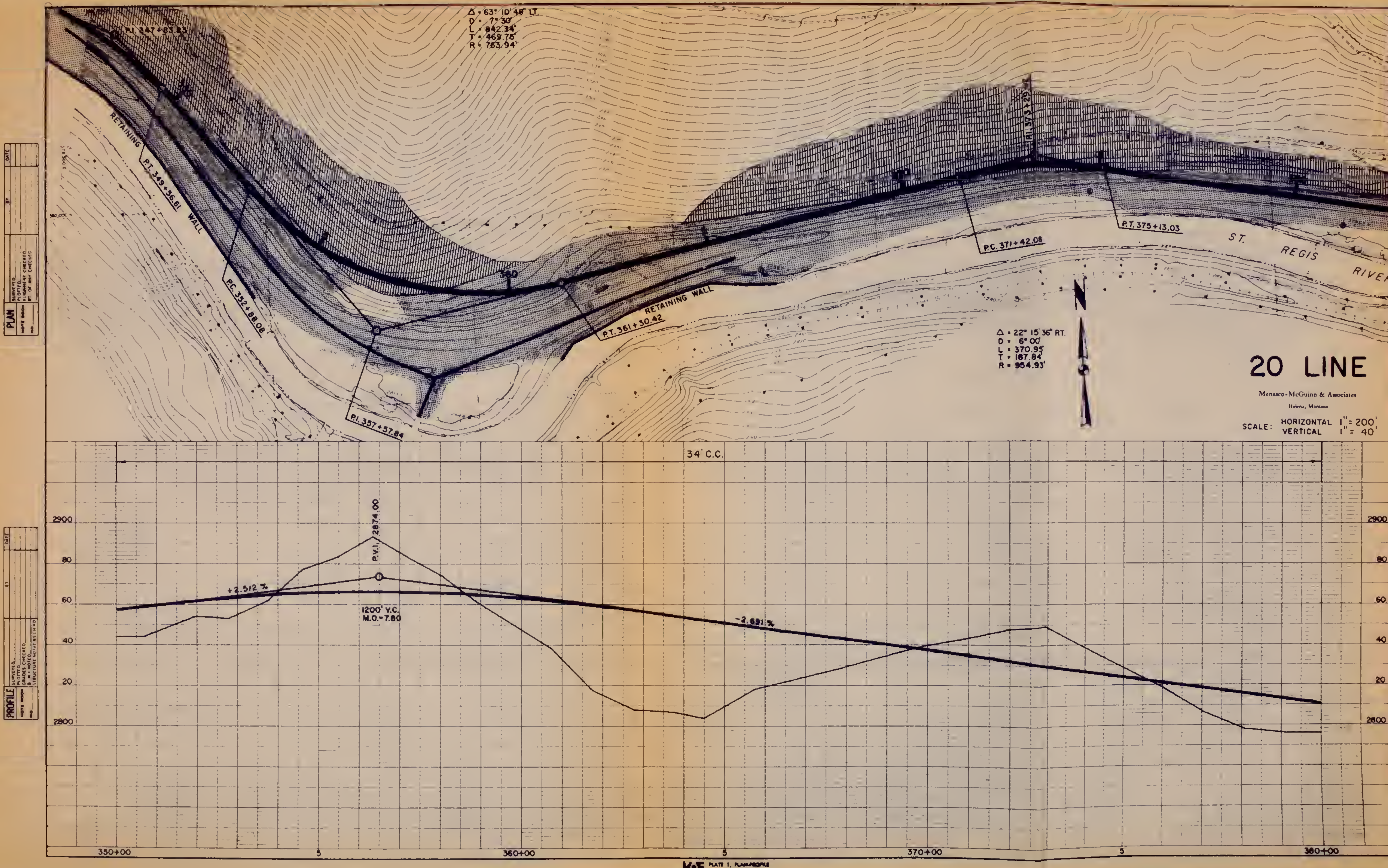
Δ = 55° 34' 12" LT.
D = 7° 00'
L = 793.83'
T = 431.28'
R = 818.51'
P.I. 263+95.41
P.C. 266+33.57
P.I. 270+64.84
P.T. 274+27.41
P.C. 280+71.86
P.T. 292+14.43
Δ = 68° 33' 00" RT.
D = 6° 00'
L = 1142.57'
T = 650.85'
R = 954.93'
ST. REGIS RIVER
DREXEL
20 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
60' C.C.
-2.000 %
P.V.I. 2950.00
800' V.C.
M.O. = 1.99
-3.991 %
3020
3000
80
60
40
20
2900
80
2860
260+00
5
270+00
5
280+00
5
290+00
PLAN
PROFILE
K+E PLATE 1. PLAN-PROFILE

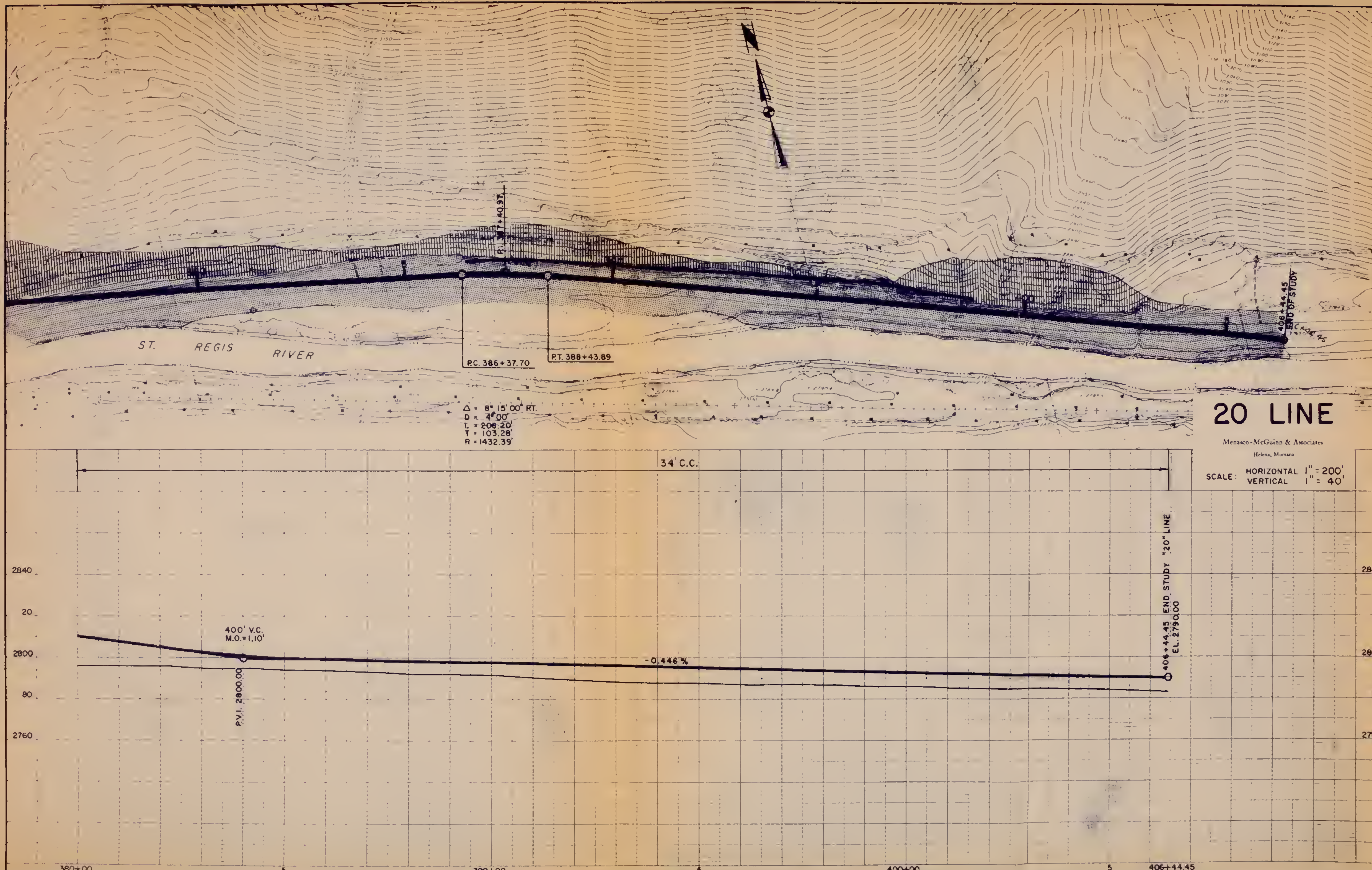


K·E PLATE 1. PLAN-PROFILE



20 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
Δ = 49° 31' 12" LT.
D = 6° 00'
L = 825.27'
T = 440.39'
R = 954.93'
P.T. 317 + 58.92
P.C. 326 + 08.60
P.I. 330 + 49.00
P.I. 347 + 83.23
P.C. 346 + 04.31
P.T. 349 + 56.61
RETAINING WALL
Δ = 24° 39' 36" RT.
D = 7° 00'
L = 352.31'
T = 178.93'
R = 818.51'
34' C.C.
-0.817 %
400' V.C.
M.O. = 1.70
P.V.I. 2820.00
-2.512 %
2860
40
20
2800
80
2760
320+00
5
330+00
5
340+00
5
350+00
PLAN
SURVEYED
PLOTTED
ALIGNMENT CHECKED
RT OF WAY CHECKED
NOTE BOOK
NO.
BY
DATE
PROFILE
GRADES CHECKED
STRUCTURE NOTATIONS CHECKED
K+E PLATE 1, PLAN-PROFILE


Δ = 63° 10' 48" LT.
D = 7° 30'
L = 842.34'
T = 469.75'
R = 763.94'
P.I. 347+83.83
RETAINING WALL
P.T. 349+56.61
P.C. 352+88.08
P.I. 357+57.84
360
P.T. 361+30.42
RETAINING WALL
P.C. 371+42.08
P.I. 373+29
P.T. 375+13.03
ST. REGIS RIVER
Δ = 22° 15' 36" RT.
D = 6° 00'
L = 370.95'
T = 187.84'
R = 954.93'
N
20 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
PLAN
PROFILE
34' C.C.
P.V.I. 2874.00
+2.512 %
1200' V.C.
M.O.=7.80
-2.691 %
2900
80
60
40
20
2800
350+00
5
360+00
5
370+00
5
380+00
K+E PLATE 1, PLAN-PROFILE



PLAN
PROFILE
ST. REGIS RIVER
P.I. 387+40.97
P.C. 386+37.70
P.T. 388+43.89
406+44.45 END OF STUDY
Δ = 8° 15' 00" RT.
D = 4°00'
L = 206.20'
T = 103.28'
R = 1432.39'
20 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
34' C.C.
400' V.C.
M.O. = 1.10'
P.V.I. 2800.00
-0.446 %
406+44.45 END STUDY "20" LINE
EL. 2790.00
2840
20
2800
80
2760
380+00
5
390+00
5
400+00
5
406+44.45
K+E PLATE 1. PLAN-PROFILE

Part IV
"21" Line

P A R T   I V

"21" LINE

A. INTRODUCTION

The "21" Line was studied in an effort to achieve the best horizontal alignment throughout the project.

B. HORIZONTAL ALIGNMENT

Beginning at the Henderson interchange area, Station 130+00, the alignment swings away from the PTW to a sidehill location by introduction of a 4-degree curve to the left. From this 4-degree curve, at Station 146+36 to Station 186+83, the alignment is a tangent ahead to its connection with the "20" Line. At Station 186+83, a 4 - degree curve to the right makes this connection to the "20" Line at Station 206+44. The alignment from this point through to the east end of the project uses the "20" Line horizontal alignment.

C. VERTICAL ALIGNMENT

From Station 130+00, the vertical alignment rises at +5 percent to climb over the nose at Station 155+00 for 1,500 feet. After reaching a highpoint elevation of 3,078 feet, the alignment begins to decend at a rate of -1.264 percent, and crosses the St. Regis River and the railroad approximately 120 feet above these features. The alignment then crosses the nose at Station 175+00 with a 150 - foot cut and proceeds back across the railroad and the river to connect with the "20" Line at Station 206+44. The vertical alignment has been designed to remain consistent with the long horizontal tangents by introducing long vertical tangents with small vertical grade differences.

D. ROADWAY CROSS SECTION

Template A of the "21" Line is based upon 34 - foot centers throughout the project length.

Template B will use 34-foot centers from Station 130+00 through Station 206+44 and the "20" Line B Template from Station 206+44 through to the end of the project.

E. ANNUAL COST

The summary of annual costs indicate all of the different items of costs. It should be noted the "21" Line has the lowest

Review Comments & Notes

operating cost of all the lines at $1,107,873. The construction costs, however, for the A Template are $5,618,761 and the B Template are $5,842,537.

F. RIVER ACCESS AND CONFLICT

The "21" Line provides continuous river access from the Henderson interchange to the Drexel interchange.

Beginning at Station 130+00 at the Henderson interchange area to Station 206+44, only minor river conflict occurs. From Station 206+44 to the end of the project, the river conflicts are the same as those described for the "20" Line.

G. MAINTENANCE

Due to icing conditions, the two long bridges at Station 170+00 and Station 182+00 require sanding and special maintenance.

H. CONSTRUCTION METHODS

The "21" Line includes the construction of the two bridges at Station 170+00 and Station 182+00, which would be considered "high" bridges. These structures stand 120 feet above the St. Regis River and would constitute a major construction project to any contractor. The working season being short in this area, means that two construction seasons would be required to construct the bridges.

The "21" Line does offer good traffic control during construction, inasmuch as the PTW could be maintained from Henderson to Drexel.

The earthwork balance from Station 172 + 40 through Station 180+30, which is across the nose, is not a balanced section and would require excavation to be hauled across the railroad and river or to be wasted on the south side of the river. The "21" Line requires 3,283,211 cubic yards of excavation for the A Template, and 3,762,216 cubic yards of excavation for the B Template.

I. SCENIC EVALUATION

This roadway affords a driver not only the high panoramic view, but also an easy horizontal alignment to drive. This condition is especially true from Station 130+00 to Station 206+44

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(See Photo No. 4, Appendix A). The horizontal alignment from Station 206+44 to the Drexel interchange is not as relaxing; however, the view is as indicated in Photo No. 5 of Appendix A.

J. UTILITIES

The utilities in conflict with the "21" Line are the trunk telephone line, the power line, and the railroad. The only conflict with the railroad will be at the structure crossings at Station 170+15 and Station 181+05.

This alignment would require relocation of eight power "H" poles. Access to the relocated poles could be provided between the Henderson and Drexel interchanges by the PTW.

One-hundred-forty-three (143) trunk telephone poles would require relocating; however, the access along the PTW, as mentioned above, would be available for the relocations and maintenance access.

K. DESIGN STANDARDS

The design standards for the "21" Line are the same as in Part I-C. No special design standards were used for this line.

L. TRAFFIC

The traffic movements and access points are the same as shown in Part I-E.

M. RIGHT-OF-WAY

As mentioned in "Utilities" above, this line crosses 120 feet above the railroad. The substructure of the bridges would be constructed outside of the railroad right-of-way.

The total "take" for right-of-way will amount to 177.2 acres. Of this, 20.6 acres will be taken from the DeCoursey property, 25.2 acres from the Knowles property, and 7.5 acres from the Mayo property. Five-tenths (0.5) acres are required from the State of Montana. The existing right-of-way constitutes 37.4 acres. The remainder of 86 acres would be acquired from the United States Government.

N. STRUCTURES

The following major structure data sheets denote the location and size of the structure. The "21" Line has 108,496 square

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feet of bridges and 1,410 linear feet of retaining walls. Again, the high bridges at Stations 170+00 and 182+00 constitute a major construction project.

(1) Henderson Interchange

Refer to Part II - Henderson Interchange

(3) Station 166+54 to Station 172+26

A single four-lane structure is proposed at this location, having a width between curbs of 78 feet and a total length of 572 feet. The total deck area will be 44,616 square feet. This structure, as proposed, shall consist of three spans of approximately 212 feet, 192 feet, and 168 feet. The end spans will cantilever over the interior piers to the inflection points of the center span as determined from a continuous structure analysis under the uniform load condition, and hinges will be provided at these locations. Provision for expansion in connection with the hinge will be made at one of the hinge locations. Interior and end piers will be skewed at approximately 25 degrees.

The superstructure shall consist of a poured concrete slab composite with ten steel plate girder stringers spaced at approximately 8 feet, 3 inches on centers. The depth of the plate girders will be varied along their profiles to conform to the maximum moment envelope curve with deep haunches being provided at the support points and a minimum depth section at mid-span. Depth of haunches at support points will be in the order of eight to ten feet, depending on the span under consideration; and depth at the center of span will be in the range of five to six feet. Stiffeners shall be provided as required on the interior face of fascia stringers only such that a clean profile is presented on the exterior face of the superstructure.

The piers shall be poured concrete of the "T head" type with two or three columns as dictated by the final design. The columns shall be of rectangular cross section and shall taper from a maximum section at the top of foundation to a minimum section at the bottom of the pier head. Taper of the columns is especially desirable in this instance, as we are dealing with a relatively high structure.

Again, it is anticipated that because of the geological conditions at the site, the foundations for the piers could be spread footings; however, again, this would have to be substantiated by test borings.

(3) Station 179+00 to Station 184+80

A single four-lane structure is proposed at this location, having a width between curbs of 78 feet and a total

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length of 580 feet; the total deck area being 45,240 square feet.

With exception of the three spans which are approximately 180 feet, 230 feet, and 170 feet, this structure will be similar in all other respects to the structure between Stations 166+54 and 172+26.

(4) Drexel Interchange

Refer to Part III - "20" Line.

O. GEOLOGY

The geology for the "21" Line is the same as discussed in Part I-H.

P. DRAINAGE

The "21" Line requires no drainage structures from Station 132+50 through Station 206+44.

At Station 132 + 50, the "21" Line crosses Twelvemile Creek. This crossing will require a double 15' x 9' box culvert. From Station 206+44 ahead to the east end of the project, the drainage is the same as the "20" Line described in Part III.

Q. HIGHWAY RATING INDEX

The summary section of this report shows how this line compared with others in each of the nine individual comparisons. All data used to develop the "21" Line portion of each comparison is included in the following pages.

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HORIZONTAL ALIGNMENT - "21" LINE

Comparison Items	Amount	Points
Total Length of Comparison		
Feet.	29,100.09'	
Miles	5.511	10
Total Number of Curves	16	
Curve Frequency Per Mile	2.90	10
Maximum Degree of Curvature.	7.50°	6
Average Degree of Curvature.	5.81°	10
Average Length of Curve.	773.72'	8
Average Deflection Per Curve	42.02°	8
Total Deflection Over Comparison	672.39°	10
Average Deflection Per Mile.	122.01°	10
Total Feet Curvilinear Roadway	12,379.47'	10
Percent of Curvilinear Roadway	42.5%	10
Average Tangent Between Curves	958.84'	10
Total Number of Structures	8	7
TOTAL POINTS.		109

Review Comments & Notes

HORIZONTAL ALIGNMENT DATA - "21" LINE

Curve Number	Deflection Angle	Degree of Curve	Length	Distance P.C. to P.T.
1*	62.18°	2.75°	2,260.98'	
				620.45'
2	50.82°	4.00°	1,270.55'	
				4,046.63'
3	9.72°	4.00°	243.02'	
				243.03'
4	49.07°	6.50°	754.94'	
				667.39'
5	45.51°	7.00°	650.14'	
				1,151.23'
6	34.53°	5.00°	690.56'	
				805.59'
7	65.19°	7.25°	899.18'	
				248.16'
8	55.57°	7.00°	793.83'	
				644.45'
9	68.55°	6.00°	1,142.57'	
				285.94'
10	41.90°	6.00°	698.41'	
				1,181.92'
11	26.48°	7.00°	378.22'	
				849.68'
12	49.52°	6.00°	825.27'	
				1,170.44'
13	24.66°	7.00°	352.31'	
				331.47'
14	63.16°	7.50°	842.34'	
				1,011.66'
15	22.26°	6.00°	370.95'	
				1,124.67'
16	8.25°	4.00°	206.20'	
Total	672.39°	92.96°	12,379.47'	14,382.60'
Average	42.02°	5.81°	773.72'	958.84'

Percent of Curvilinear Roadway = $\frac{12,379.47}{29,100.09}$ = 42.5%

Average Deflection Per Mile = $\frac{672.39}{5.511}$ = 122.01°

* Henderson Interchange Area.

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VERTICAL ALIGNMENT - "21" LINE

Comparison Items	Amount	Points
Total Length of Comparison:		
Feet.	29,100.09'	
Miles	5.511	10
Total Number of Vertical Curves.	12	
Curve Frequency Per Mile	2.18	8
Average Length of Vertical Curve	850.00'	
Average Algebraic Difference	3.663%	
K Factor (1)	232.05	4
Maximum Grade in Comparison.	5.000%	5
Average Grade in Comparison.	2.123%	6
Percentage of Roadway with:		
5% Grade or More.	8.6%	6
3% - 5% Grade	13.1%	8
2% - 3% Grade	31.1%	6
Less than 2% Grade.	47.3%	4
TOTAL POINTS.		57

(1) K = Average length of vertical curve divided by average algebraic difference.

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VERTICAL ALIGNMENT DATA - "21" LINE

Sta. VPI	Distance VPI-VPI	Per Cent Grade	G2-G1	Length V.C.	K Factor
100+00					
	1,457.5'	+1.438%			
114+57.5			3.444	800'	232
	1,542.5'	-2.006%			
130+00			7.006	800'	114
	2,500'	+5.000%			
155+00			6.264	1,200'	191
	3,250'	-1.264%			
187+50			2.071	800'	386
	1,300'	-3.335%			
200+50			2.785	600'	215
	594.55'	-0.556%			
206+44.55)	Equation				
221+88.91)					
	1,211.09'	-0.556%			
234+00			2.904	800'	275
	1,300'	+1.538%			
247+00			3.538	800'	226
	2,600'	-2.000%			
273+00			1.990	800'	402
	2,500'	-3.990%			
298+00			3.173	800'	252
	3,700'	-0.817%			
335+00			3.329	400'	120
	2,150'	+2.512%			
356+50			5.203	1,200'	230
	2,750'	-2.691%			
384+00			2.245	400'	178
	2,244.5'	-0.446%			
406+44.5					
Total		27.593%	43.956	9,600'	2824.48
Average		2.123%	3.663	800'	235.37

Review Comments & Notes

ROADWAY CROSS SECTION - "21" LINE

	Template A		Template B	
Comparison Items	Amount	Points	Amount	Points
34' Center-Center, Miles . . .	4.984		3.641	
60' Center-Center, Miles . . .	0.527		1.876	
34' Center-Center.	90.44%	8	66.00%	12
60' Center-Center.	9.56%	8	34.00%	12
TOTAL POINTS.		16		24

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ROADWAY CROSS SECTION DATA - "21" LINE

	34' Center-Center (Miles)	60' Center-Center (Miles)
Template A:		
*100+00 to 127+45.46		0.527
Remainder of "21" Line	4.984	
Total	4.984	0.527
Per Cent	90.44%	9.56%
Template B:		
*100+00 to 127+45.46		0.527
127+45.46 to 195+93.51	1.297	
195+93.51 to 203+48.45 (Transition)	0.071	0.071
203+48.45 to 206+44.55)) Equ.		0.056
221+88.91 to 280+71.86) (206+44.55 BK = 221+88.91 AH)		1.114
280+71.86 to 292+14.43 (Transition)	0.108	0.108
292+14.43 to 406+44.55	2.165	
Total	3.641	1.876
Per Cent	66.00%	34.00%

*Henderson Interchange

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COST ESTIMATE - "21" LINE

	CAPITAL RECOVERY FACTOR		TEMPLATE A 34' Ctr-Ctr Only		TEMPLATE B 34' Ctr-Ctr & 60' Ctr-Ctr	
	Years	Interest	Const. Cost	Annual Cost	Const. Cost	Annual Cost
Guard Rail......................	20	0.0872	$ 310,434	$ 27,065	$ 257,666	$ 22,465
Base, Surfacing & Pavement......	20	0.0872	1,005,737	87,685	1,013,504	88,362
Grading, Earthwork & Channel Change................	40	0.0665	1,969,927	130,924	2,257,330	150,026
Drainage........................	40	0.0665	166,370	11,057	193,824	12,882
Retaining Walls.................	50	0.0634	84,600	5,367	84,600	5,367
Major Structures................	50	0.0634	1,924,800	122,118	1,878,720	119,194
Cantilever Section..............	50	0.0634	-0-	-0-	-0-	-0-
Utilities.......................	50	0.0634	79,500	5,044	79,500	5,044
Rest Area.......................	20	0.0872	28,685	2,500	28,685	2,500
Traffic Control.................	20	0.0872	48,708	4,246	48,708	4,246
TOTAL CONSTRUCTION COST............................			$5,618,761		$5,842,537	
Sub-Total Annual Cost........................				$ 392,006		$ 410,086
Percentage of Construction Cost Differential......			142.5%		148.5%	
Maintenance:						
Interstate 4-Lane @ $3,000/Mile..............				16,554		16,554
Crossroad & Interchange Ramps @ $1,500/Mile..				4,689		4,689
Operating Cost.....................................				1,107,873		1,107,873
TOTAL ANNUAL COST..................................				$1,521,122		$1,539,202

RIVER ACCESS & CONFLICT - "21" LINE

Comparison Items	Amount	Points
Total River Access, Miles.	4.128	8
Percent of Present Access Retained	71%	8
Present Access Road (PTW) Relocated, Miles.	0.414	8
Minor River Conflict, Feet(1).	1,630'	4
Major River Conflict, Feet(2).	1,410'	9
River Improvement(3)	None	5
River Access Continuous Between Henderson and Drexel.	Yes	8
TOTAL POINTS.		50

(1) Encroachment on present river bed not requiring channel change or retaining wall.

(2) Encroachment on present river bed requiring undesirable channel change or retaining wall.

(3) Desirable channel change, flood plain improvement, etc.

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RIVER ACCESS & CONFLICT DATA

"21" LINE, TEMPLATE B

Items	1	(b) 2	3	4	5
(a) PTW Stations	Amt. River Access	Percent Access Main-tained	Total Constr. Items 1 & 2	Amt. Minor Conflict	Amt. Major Conflict
Henderson Interchange	2,696'	8.78%			
0+00 to 48+50	4,850'	15.80%			
48+50 to 52+50	400'	1.30%	400'	250'	
52+50 to 83+75	3,125'	10.18%			
83+75 to 88+50	475'	1.55%	475'	380'	
88+50 to 104+50	1,600'	5.21%			
104+50 to 109+00	450'	1.47%	450'		
109+00 to 125+00	1,600'	5.21%			
125+00 to 128+30	330'	1.07%	330'		
128+30 to 144+70	1,640'	5.34%			
144+70 to 150+00	530'	1.73%	530'		
150+00 to 191+00	4,100'	13.36%			
Beyond Drexel	0'	0.00%		1,000'	1,410'
Total Feet	21,796'	71.00%	2,185'	1,630'	1,410'
Total Miles	4.128	71.00%	0.414		

(a) 127+45 I-90 = 0+00 PTW (Comparison Equation Only).

(b) Present access is approximately 5.81 miles.

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MAINTENANCE - "21" LINE

Comparison Items	Template A Amount	Template A Points	Template B Amount	Template B Points
Snow Removal:				
Percent of Roadway with Depressed Median.	9.56%	8	34.00%	12
Rock Removal:				
Linear Feet of Cut Ditch	14,032'	16	14,920'	10
Structure Maintenance:				
Linear Feet of Structures.	3,092'	11	3,092'	11
Sanding:				
Linear Feet of Problem Roadway	7,997'	5	7,997'	5
TOTAL POINTS.		40		38

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MAINTENANCE DATA - "21" LINE

SNOW REMOVAL

$$\frac{\text{Total Miles of Depressed Median}}{\text{Total Length of "21" Line}} = \frac{1.876}{5.517} = 34.00\%$$

ROCK REMOVAL

Location	Cut Ditch (Lin.Ft.)
109+00 to 111+30	230'
134+00 to 140+00, Rt & Lt	1,200'
140+00 to 152+00	1,200'
152+00 to 159+40, Rt & Lt	740'
172+50 to 178+00, Rt & Lt	550'
187+50 to 196+50, Rt & Lt	900'
221+00 to 245+00, + 900' Rt	3,100'
245+00 to 258+30	1,330'
262+00 to 270+00, Rt & Lt	1,600'
284+00 to 296+00	1,200'
315+00 to 326+50	1,150'
346+00 to 358+50	1,250'
369+00 to 376+00	700'
TOTAL	14,920'

STRUCTURE MAINTENANCE

Total Linear Feet of Major Structures	1,682'
Total Linear Feet of Retaining Wall	1,410'
TOTAL Linear Feet Structure Maintenance	3,092'

SANDING

Total Linear Feet of Roadway with 3% Grade or More	6,314.72'
Total Linear Feet of Bridge Deck	1,682.00'
TOTAL Linear Feet of Problem Roadway	7,996.72'

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CONSTRUCTION METHODS - "21" LINE

Comparison Items	Amount	Points
Traffic Control.		10
Earthwork Balance.		7
Simplicity		8
TOTAL POINTS		25

TRAFFIC CONTROL

(Miles)

Length of Detour Comprised of PTW.	4.128	8
Length of Detour to be Constructed	2.280	10
Length of Detour Separated from Construction	4.128	8
Length of Detour on or Adjacent to Construction	2.280	10
TOTAL POINTS		36

EARTHWORK BALANCE

Does the Total Earthwork Balance?.	Yes	8
Total Number of Balance Points	8	7
Average Distance Between Balance Points (Miles)	0.612	8
TOTAL POINTS		23

SIMPLICITY

Total Linear Feet Major Structures	1,682'	6
Total Linear Feet Retaining Wall	1,410'	9
TOTAL POINTS		15

PART IV - Table 12

Review Comments & Notes

CONSTRUCTION METHODS DATA

SIMPLICITY - "21" LINE

MAJOR STRUCTURE DATA

Location	Length	Width	Deck Area (Sq.Ft.)
Henderson Interchange, Eastbound	140'	38'	5,320
Henderson Interchange, Westbound	140'	38'	5,320
166+50 to 172+30	572'	78'	44,616
179+00 to 184+80	580'	78'	45,240
Drexel Interchange, Crossroad	250'	32'	8,000
TOTAL	1,682'		108,496

RETAINING WALL DATA

Location	Linear Feet
346+50 to 355+00	850'
361+00 to 366+60	560'
TOTAL	1,410'

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SCENIC EVALUATION - "21" LINE

	Template A		Template B	
Comparison Items	Amount	Points	Amount	Points
Panorama	*	8	*	14
Total Area Cut Faces (Square Yards)	260,551	16	325,689	8
Number of Areas Where View is Enhanced Over a High Fill.	4	13	4	13
TOTAL POINTS.		37		35

* Value judgment based upon field survey; see Scenic "Basis of Evaluation".

Review Comments & Notes

SCENIC EVALUATION DATA - "21" LINE

Location	Cut Face (Sq.Yd.)
109+00 to 111+30	3,644
134+00 to 140+00, Rt & Lt.	14,222
140+00 to 152+00	16,444
152+00 to 159+40, Rt & Lt.	12,444
172+50 to 178+00, Rt & Lt.	16,444
187+50 to 196+50, Rt & Lt.	26,340
221+00 to 245+00, + 900' Rt.	69,778
245+00 to 258+30	27,822
262+00 to 270+00, Rt & Lt.	29,067
284+00 to 296+00	28,755
315+00 to 326+50	24,311
346+00 to 358+50	26,667
369+00 to 376+00	21,778
376+00 to 404+44.45	11,555
TOTAL	325,689

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SCENIC EVALUATION DATA - "21" LINE

Location	Cut Face (Sq.Yd.)
109+00 to 111+30	3,644
134+00 to 140+00, Rt & Lt.	14,222
140+00 to 152+00	16,444
152+00 to 159+40, Rt & Lt.	12,444
172+50 to 178+00, Rt & Lt.	16,444
187+50 to 196+50, Rt & Lt.	26,340
221+00 to 245+00, + 900' Rt.	69,778
245+00 to 258+30	27,822
262+00 to 270+00, Rt & Lt.	29,067
284+00 to 296+00	28,755
315+00 to 326+50	24,311
346+00 to 358+50	26,667
369+00 to 376+00	21,778
376+00 to 404+44.45	11,555
TOTAL	325,689

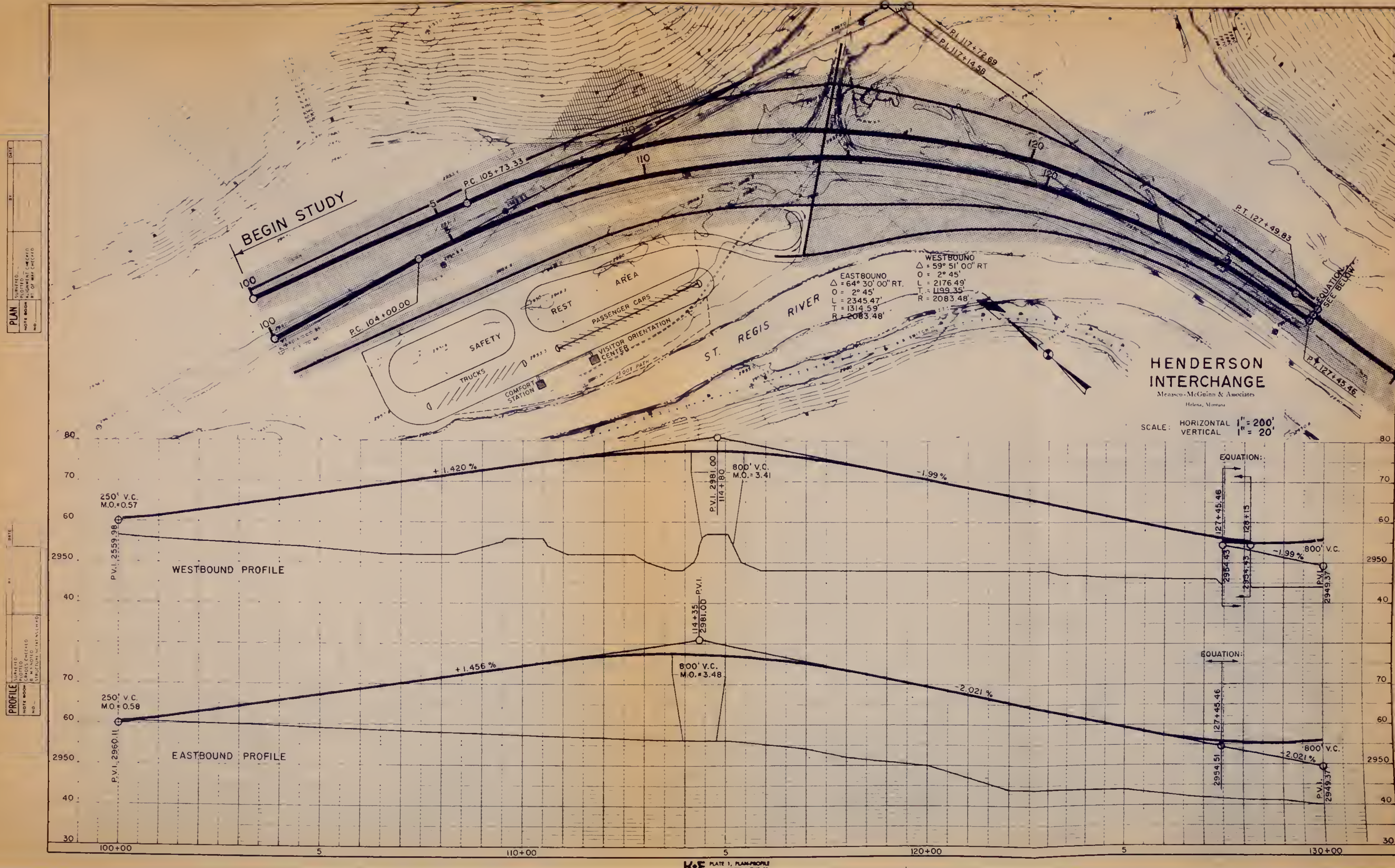
Review Comments & Notes

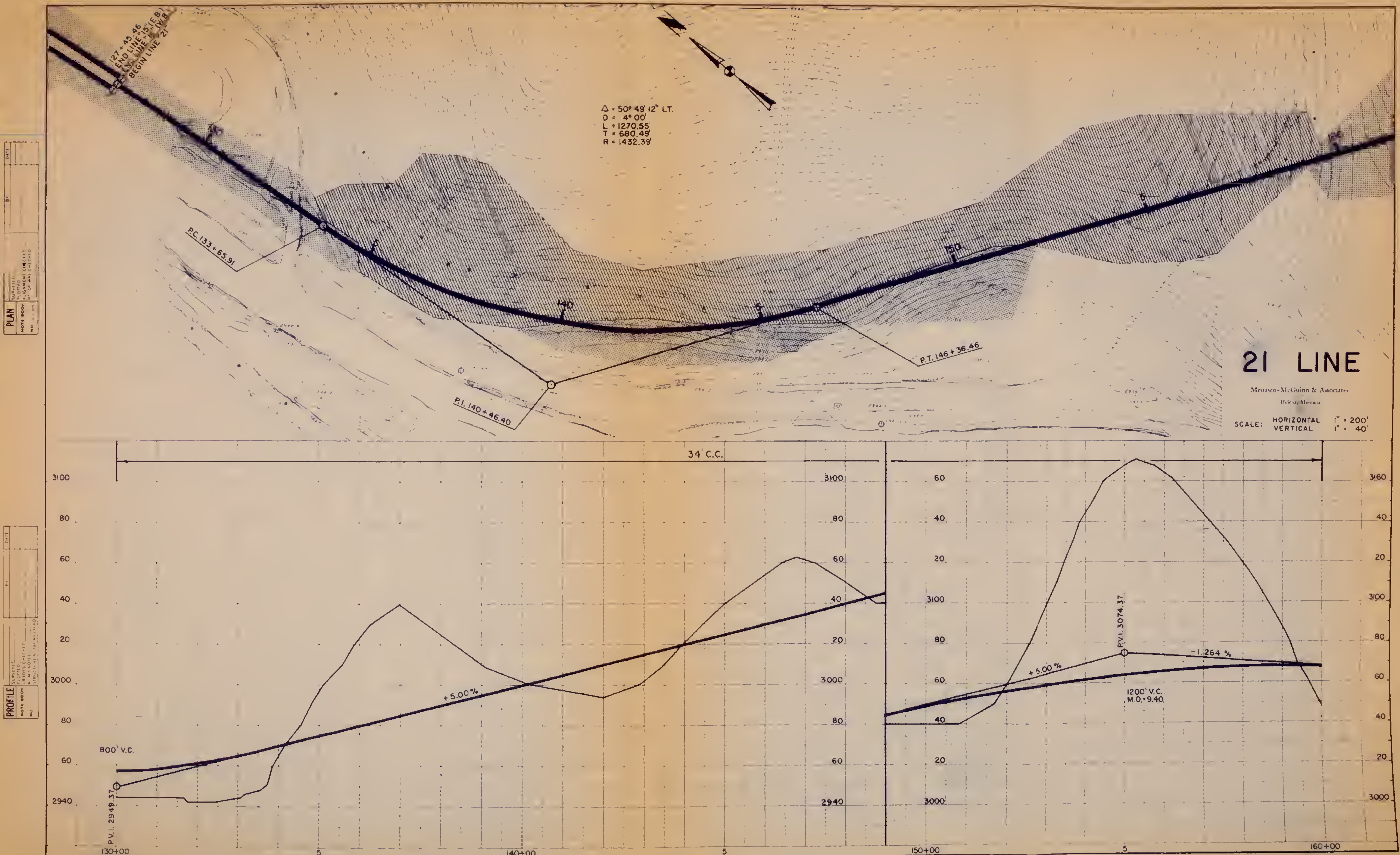
UTILITIES - "21" LINE

Comparison Items	Points
Versatility of Location*	6

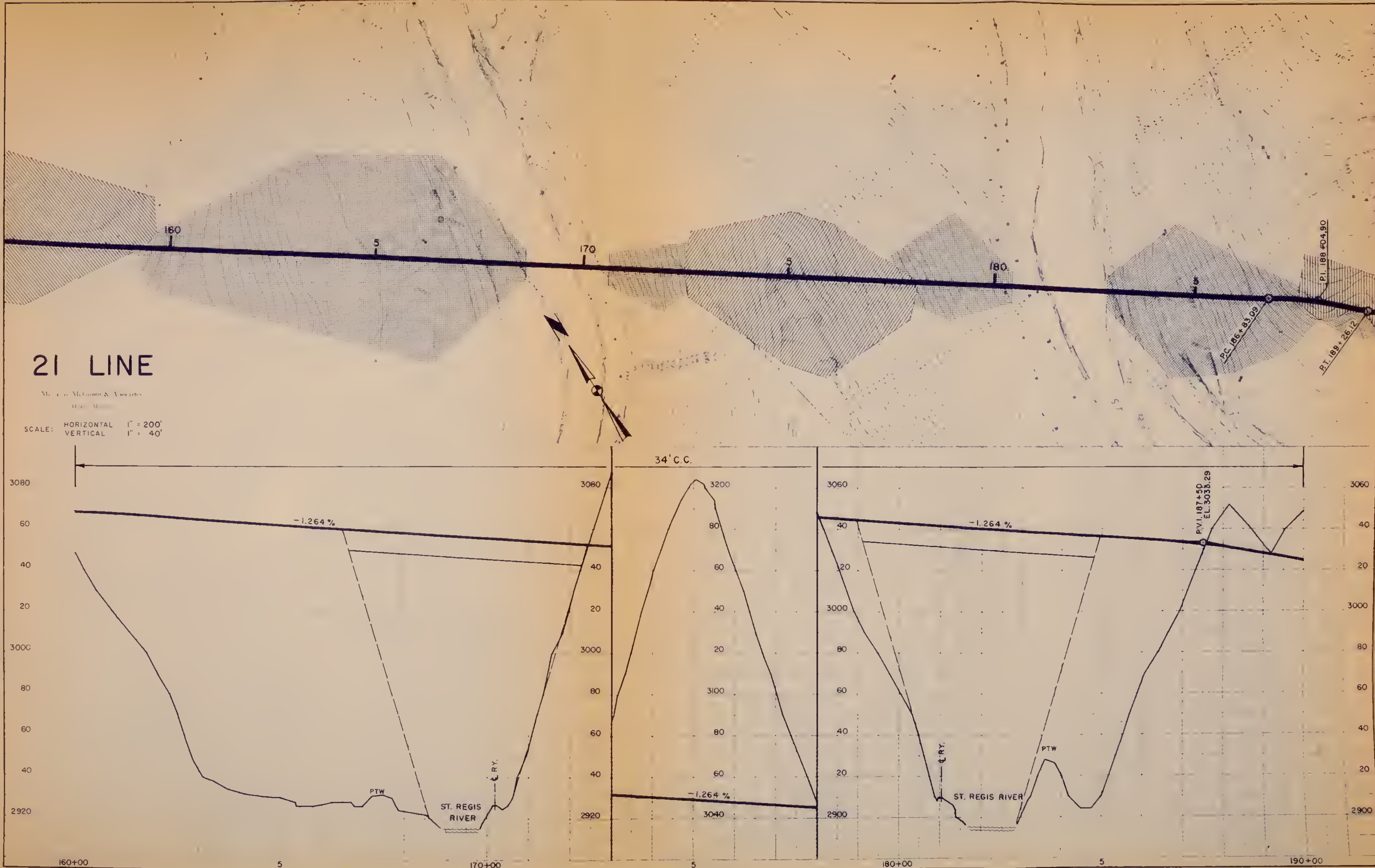
* For explanation of how points were assigned, see "Basis of Evaluation".

Review Comments & Notes


BEGIN STUDY
P.C. 105+73.33
P.C. 104+00.00
P.I. 117+72.69
P.I. 117+14.58
P.T. 127+49.83
P.I. 127+45.46
EQUATION SEE BELOW
SAFETY
REST
AREA
TRUCKS
PASSENGER CARS
VISITOR ORIENTATION CENTER
COMFORT STATION
FOOT PATH
ST. REGIS RIVER
EASTBOUND
Δ = 64° 30' 00" RT.
D = 2° 45'
L = 2345.47'
T = 1314.59'
R = 2083.48'
WESTBOUND
Δ = 59° 51' 00" RT
D = 2° 45'
L = 2176.49'
T = 1199.35'
R = 2083.48'
HENDERSON
INTERCHANGE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 20'
WESTBOUND PROFILE
250' V.C.
M.O. = 0.57
P.V.I. 2959.98
+1.420 %
P.V.I. 2981.00
114+80
800' V.C.
M.O. = 3.41
-1.99 %
EQUATION:
127+45.46
2954.43
128+15
2954.43
800' V.C.
P.V.I. 2949.37
EASTBOUND PROFILE
250' V.C.
M.O. = 0.58
P.V.I. 2960.11
+1.456 %
114+35
2981.00
P.V.I.
800' V.C.
M.O. = 3.48
-2.021 %
EQUATION:
127+45.46
2954.51
800' V.C.
P.V.I. 2949.37
100+00
110+00
120+00
130+00
PLAN
PROFILE
K+E PLATE 1, PLAN-PROFILE



PLAN
Δ = 50° 49' 12" LT.
D = 4° 00'
L = 1270.55'
T = 680.49'
R = 1432.39'
P.C. 133+65.91
P.I. 140+46.40
P.T. 146+36.46
140
150
21 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
PROFILE
34' C.C.
800' V.C.
P.V.I. 2949.37
+5.00%
P.V.I. 3074.37
+5.00 %
-1.264 %
1200' V.C.
M.O. = 9.40
130+00
140+00
150+00
160+00


PLAN
PROFILE
21 LINE
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
160
5
170
180
P.C. 186+83.09
P.I. 188+04.90
P.T. 189+26.12
34' C.C.
-1.264 %
P.V.I. 187+50
EL. 3033.29
PTW
ST. REGIS RIVER
℄ RY.
3080
3060
3200
3100
3040
3000
2920
2900
160+00
170+00
180+00
190+00
K•E PLATE 1, PLAN-PROFILE


21 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
Δ = 45° 30' 36" LT.
D = 7° 00'
L = 650.14'
T = 343.31'
R = 818.51'
Δ = 9° 43' 12" RT.
D = 4° 00'
L = 243.02'
T = 121.80'
R = 1432.39'
Δ = 49° 04' 12" RT.
D = 6° 30'
L = 754.94'
T = 402.37'
R = 881.47'
P.I. 199 + 95.88
P.I. 188 + 04.94
P.T. 189 + 26.12
P.C. 186 + 83.09
P.C. 195 + 93.51
P.T. 203 + 48.45
P.C. 206 + 44.55
P.T. 228 + 39.05
20 LINE
EQUATION: (21 LINE) 206 + 44.55 BK. = 221 + 88.91 AH. (20 LINE)
34' C.C.
60' C.C.
EQUATION
(END) 206 + 44.55 (21 LINE) BK. 221 + 88.91 (20 LINE) AH.
P.V.I. 3033.29
-1.267 %
-3.335 %
-0.556 %
400' V.C.
M.O. = 1.03
600' V.C.
M.O. = 2.08
P.V.I. 2989.93
3080
60
40
20
3000
80
60
40
2920
5
190+00
5
200+00
5
225+00
230+00
PLAN
PROFILE
K+E PLATE 1. PLAN-PROFILE

Part V
“22” Line

P A R T V

"22" LINE

A. INTRODUCTION

The "22" Line study was undertaken to employ the advantages of the first 1.5 miles of the "23" Line and the last 3.8 miles of the "20" Line. This was accomplished using a tangent connection between the "23" Line and the "20" Line. However, the "22" Line was studied as one complete alignment from Henderson to the end of the project.

B. HORIZONTAL ALIGNMENT

The "22" Line uses the "23" horizontal alignment to Station 180+34.98. At this point, the "22" Line connection begins and is simply a tangent 1,240 feet in length joining the "20" Line at Station 182 + 74.53 ("22" Line) which equals Station 205 + 74.39 ("20" Line). From this point, the "22" Line assumes the "20" Line alignment and is the same to the end of the project.

C. VERTICAL ALIGNMENT

The vertical alignment is common to the "23" Line and "20" Line in the same manner as the horizontal alignment. The "22" Line connection between the two has a 0.00 percent grade.

D. ROADWAY CROSS SECTION

The "22" Line has been studied twice using two different cross sections in the same manner as the "20" and "21" Lines. These studies are:

(1) Template A

Beginning immediately after the Henderson interchange (Station 127 + 45.46), the study uses a 34-foot center-to-center cross section to the end of the project.

(2) Template B

A 34-foot center-to-center cross section is used from Henderson (Station 127+45.46) across the "22" Line connection to Station 211+57. From here, a 60-foot center-to-center cross section is used to the curve leading into the Drexel interchange. The study then uses the 34-foot center-to-center cross section from there to the end of the project.

Review Comments & Notes

E. ANNUAL COST

Among the proposed hillside alignments, the "22" Line would be less expensive than the "21" Line and more expensive than the "20" Line in total annual cost. It would be less costly than either of the river-level alignments, "23" and "24".

F. RIVER ACCESS AND CONFLICT

One of the most important advantages of the "22" Line is that it will be possible to maintain a river access road between Henderson and Drexel. This can be accomplished by relocating 0.551 miles of the PTW under the major structure. In so doing, the balance of the PTW will be maintained in its present loca-

The conflict with the river is relatively minor, requiring 1,490 feet of retaining wall to confine fill slopes at the river and no channel changes.

G. MAINTENANCE

The "22" Line rated well in all four of the comparisons used under this item, with the possible exception of structure maintenance. The "22" Line requires 60 percent more major structures than the "20" Line and slightly more than the "21" Line.

The "22" Line has a lower percentage of roadway with available snow storage than any of the other lines, except the "23" Line. It also has the lowest amount of problem roadway where sanding is concerned. It compares favorably in the amount of cut ditch in which rock and debris will accumulate and require cleaning.

H. CONSTRUCTION METHODS

Traffic control during construction could be accomplished between Henderson and Drexel using 4.128 miles of the PTW and relocating 0.551 miles of the PTW. It is recommended this detour be permanently maintained as a river access road. Beyond Drexel, the problem is more complicated in that traffic will have to be routed adjacent to and/or on the construction. This is true, however, for all lines studied.

It will be possible to accomplish a balanced earthwork project on this line. The amount of excavation for Template A is 2,760,288 cubic yards and Template B has 3,275,065 cubic yards.

The "22" alignment is complicated to a greater degree by the large bridge structures across the river. However, its total structure requirements are less than either the "23" or the "24" Lines.

Review Comments & Notes

I. SCENIC EVALUATION

The panoramic view of the canyon from any of the hillside alignments should be quite impressive. It has been noted the horizontal alignment is such that the motorist can safely enjoy this view over most of the canyon from this location.

There would be approximately 300,000 square yards of cut face exposed; however, this amount is comparable to all lines studied.

J. UTILITIES

The "22" Line has the same conflict with the telephone line as the "21", "23" and "24" Lines. It has minor conflict with the 100 KVA power line.

The "22" Line provides the area adjacent to the PTW as a potential location for relocating utilities or locating future installations. Again, access through this area can be maintained between Henderson and Drexel.

K. DESIGN STANDARDS

The design standards used through the "22" Line study are identical to those used for all lines. See Part I-C.

L. TRAFFIC

The traffic volumes and movements are the same for all lines studied. See Part I-E.

M. RIGHT-OF-WAY

Right-of-way considerations and recommendations pertaining to the "22" Line are discussed in detail in Part I-F.

N. STRUCTURES

The "22" Line will require 1,666 linear feet of major bridge structures with 107,248 square feet of deck area. 1,490 linear feet of retaining wall will be required where fill slopes conflict with the river.

(1) Henderson Interchange

Refer to Part II - Henderson Interchange.

(2) Station 167+10 to Station 172+16

Refer to Part VI - "23" Line.

Review Comments & Notes

(3) <u>Station 179+80 to Station 186+10</u>

A single four-lane structure is proposed at this location, having a width of 78 feet and a total length of 630 feet, giving a total deck area of 49,140 square feet. This structure will consist of four spans of approximately 133 feet, 133 feet, 231 feet, and 133 feet respectively. The superstructure will be comprised of a poured concrete deck composite with steel plate girder stringers which will vary in depth from four to five feet in the shorter spans to approximately eight feet in the long span. The structure will approximate a continuous design with hinges located in the second and fourth spans to facilitate construction, as well as simplify the design. Expansion or fixed bearings will be arranged at the piers and in conjunction with the stringer hinges where necessary to eliminate, or minimize, unnecessary stress conditions. The piers will be skewed at an angle of approximately 25 degrees.

Other general features of this structure such as stringer spacing, pier type, and foundations will be similar to those described for the structure between Stations 166+54 and 172+26 included in Part IV - "21" Line.

(4) <u>Drexel Interchange</u>

Refer to Part III - "20" Line.

O. GEOLOGY

Geological considerations pertinent to the "22" Line are discussed in detail in Part I-H.

P. DRAINAGE

A complete discussion covering the drainage investigation, including the "22" Line, is found in Part VI-P.

Q. HIGHWAY RATING INDEX

Individual ratings and supporting data are found in the following charts. The reader is referred to the summary section of this report for a comparison with all the lines studied.

Review Comments & Notes

HORIZONTAL ALIGNMENT - "22" LINE

Comparison Items	Amount	Points
Total Length of Comparison:		
Feet.	29,344.69'	
Miles	5.558	8
Total Number of Curves	18	
Curve Frequency Per Mile	3.24	8
Maximum Degree of Curvature.	7.50°	6
Average Degree of Curvature.	5.88°	8
Average Length of Curve.	767.08'	10
Average Deflection Per Curve	41.92°	10
Total Deflection Over Comparison	754.60°	8
Average Deflection Per Mile.	135.77°	8
Total Feet Curvilinear Roadway	13,807.37'	8
Percent of Curvilinear Roadway	47.0%	8
Average Tangent Between Curves	779.61'	8
Total Number of Structures	8	7
TOTAL POINTS.		97

Review Comments & Notes

HORIZONTAL ALIGNMENT DATA - "22" LINE

Curve Number	Deflection Angle	Degree of Curve	Length	Distance P.C. to P.T.
1*	62.18°	2.75°	2,260.98'	
				685.56'
2	37.52°	4.00°	938.12'	
				876.83'
3	38.35°	4.00°	958.80'	
				1,002.95'
4	45.50°	5.50°	827.27'	
				1,240.55'
5	16.03°	6.33°	246.62'	
				336.62'
6	54.42°	7.50°	725.60'	
				305.69'
7	45.51°	7.00°	650.14'	
				1,151.23'
8	34.53°	5.00°	690.56'	
				805.59'
9	65.19°	7.25°	899.18'	
				248.16'
10	55.57°	7.00°	793.83'	
				644.45'
11	68.55°	6.00°	1,142.57'	
				285.94'
12	41.90°	6.00°	698.41'	
				1,181.92'
13	26.48°	7.00°	378.22'	
				849.68'
14	49.52°	6.00°	825.27'	
				1,170.44'
15	24.66°	7.00°	352.31'	
				331.47'
16	63.16°	7.50°	842.34'	
				1,011.66'
17	22.26°	6.00°	370.95'	
				1,124.67'
18	8.25°	4.00°	206.20'	
Total	754.60°	105.84°	13,807.37'	10,227.54'
Average	41.92°	5.88°	767.08'	601.62'

Percent of Curvilinear Roadway = $\frac{13,807.37}{29,344.69}$ = 47.0%

Average Deflection Per Mile = $\frac{754.60}{5.558}$ = 135.77°

* Henderson Interchange Area.

PART V - Table 2

Review Comments & Notes

VERTICAL ALIGNMENT - "22" LINE

Comparison Items	Amount	Points
Total Length of Comparison:		
Feet.	29,344.69'	
Miles	5.558	8
Total Number of Vertical Curves.	15	
Curve Frequency Per Mile	2.70	2
Average Length of Vertical Curve	733.33'	
Average Algebraic Difference	3.009%	
K Factor[(1)]	243.71	6
Maximum Grade in Comparison.	4.660%	9
Average Grade in Comparison.	1.867%	10
Percentage of Roadway with:		
5% Grade or More.	0.0%	9
3% - 5% Grade	15.3%	6
2% - 3% Grade	34.2%	4
Less than 2% Grade.	50.4%	6
TOTAL POINTS.		60

(1) K = Average length of vertical curve divided by average algebraic difference.

Review Comments & Notes

VERTICAL ALIGNMENT DATA - "22" LINE

Sta. VPI	Distance VPI-VPI	Per Cent Grade	G2-G1	Length V.C.	K Factor
100+00					
	1,457.5'	+1.438%			
114+57.5			3.444	800'	232
	1,542.5'	-2.006%			
130+00			6.666	800'	120
	1,000'	+4.660%			
140+00			3.186	800'	251
	1,000'	+1.474%			
150+00			0.592	800'	1351
	1,000'	+2.066%			
160+00			2.666	800'	300
	1,900'	-0.600%			
179+00			0.600	400'	666
	1,400'	0.000%			
193+00) 206+00)	Equation		3.077	800'	259
	1,000'	-3.077%			
216+00			2.521	600'	238
	1,800'	-0.556%			
234+00			2.904	800'	275
	1,300'	+1.538%			
247+00			3.538	800'	226
	2,600'	-2.000%			
273+00			1.990	800'	402
	2,500'	-3.990%			
298+00			3.173	800'	252
	3,700'	-0.817%			
335+00			3.329	400'	120
	2,150'	+2.512%			
356+50			5.203	1,200'	230
	2,750'	-2.691%			
384+00			2.245	400'	178
	2,244.5'	-0.446%			
406+44.5					
Total		29.872%	45.135	11,000'	3961.65
Average		1.867%	3.009	733'	243.71

PART V - Table 4

Review Comments & Notes

ROADWAY CROSS SECTION - "22" LINE

Comparison Items	Template A Amount	Template A Points	Template B Amount	Template B Points
34' Center-Center, Miles . . .	5.031		3.689	
60' Center-Center, Miles . . .	0.527		1.876	
34' Center-Center.	90.52%	6	66.29%	10
60' Center-Center.	9.48%	6	33.71%	10
TOTAL POINTS.		12		20

Review Comments & Notes

ROADWAY CROSS SECTION DATA - "22" LINE

	34' Center-Center (Miles)	60' Center-Center (Miles)
Template A:		
*100+00 to 127+45.46		0.527
Remainder of "22" Line	5.031	
Total	5.031	0.527
Per Cent	90.52%	9.48%
Template B:		
*100+00 to 127+45.46		0.527
127+45.46 to 192+74.53)) Equ.	1.237	
205+74.39 to 211+57.62) (192+74.53 BK = 205+74.39 AH)	0.110	
211+57.62 to 218+83.22 (Transition)	0.069	0.069
218+83.22 to 280+71.86		1.172
280+71.86 to 292+14.43 (Transition)	0.108	0.108
292+14.43 to 406+44.45	2.165	
Total	3.689	1.876
Per Cent	66.29%	33.71%

* Henderson Interchange

Review Comments & Notes

COST ESTIMATE - "22" LINE

	CAPITAL RECOVERY FACTOR		TEMPLATE A 34' Ctr-Ctr Only		TEMPLATE B 34' Ctr-Ctr & 60' Ctr-Ctr	
	Years	Interest	Const. Cost	Annual Cost	Const. Cost	Annual Cost
Guard Rail	20	0.0872	$ 317,929	$ 27,718	$ 274,822	$ 23,960
Base, Surfacing & Pavement	20	0.0872	1,014,584	88,456	1,022,424	89,140
Grading, Earthwork & Channel Change	40	0.0665	1,656,173	110,072	1,965,039	130,600
Drainage	40	0.0665	166,370	11,057	193,824	12,882
Retaining Walls	50	0.0634	89,400	5,672	89,400	5,672
Major Structures	50	0.0634	1,899,840	120,534	1,854,400	117,651
Cantilever Section	50	0.0634	-0-	-0-	-0-	-0-
Utilities	50	0.0634	77,500	4,917	77,500	4,917
Rest Area	20	0.0872	28,685	2,500	28,865	2,500
Traffic Control	20	0.0872	48,724	4,247	48,724	4,247
TOTAL CONSTRUCTION COST			$5,299,205		$5,554,818	
Sub-Total Annual Cost				$ 375,173		$ 391,569
Percent of Construction Cost Differential			134.5%		141.0%	
Maintenance:						
Interstate 4-Lane @ $3,000/Mile				16,692		16,692
Crossroad & Interchange Ramps @ $1,500/Mile				4,689		4,689
Operating Cost				1,115,010		1,115,010
TOTAL ANNUAL COST				$1,511,564		$1,527,960

RIVER ACCESS & CONFLICT - "22" LINE

Comparison Items	Amount	Points
Total River Access, Miles.	4.128	8
Percent of Present Access Retained	71%	8
Present Access Road (PTW) Relocated, Miles.	0.551	6
Minor River Conflict, Feet(1).	1,500'	8
Major River Conflict, Feet(2).	1,490'	6
River Improvement(3)	None	5
River Access Continuous Between Henderson and Drexel.	Yes	8
TOTAL POINTS.		49

(1) Encroachment on present river bed not requiring channel change or retaining wall.

(2) Encroachment on present river bed requiring undesirable channel change or retaining wall.

(3) Desirable channel change, flood plain improvement, etc.

Review Comments & Notes

RIVER ACCESS & CONFLICT DATA

"22" LINE, TEMPLATE B

Items	1	(b) 2	3	4	5
(a) PTW Stations	Amt. River Access	Percent Access Main-tained	Total Constr. Items 1 & 2	Amt. Minor Conflict	Amt. Major Conflict
Henderson Interchange	2,696'	8.78%			
0+00 to 48+25	4,825'	15.72%			
48+25 to 54+50	625'	2.04%	625'		
54+50 to 82+75	2,825'	9.20%			
82+75 to 88+50	575'	1.87%	575'	500'	80'
88+50 to 100+00	1,150'	3.75%			
100+00 to 191+00	9,100'	29.64%	1,710'		
Beyond Drexel	0'	0.00%		1,000'	1,410'
Total Feet	21,796'	71.00%	2,910'	1,500'	1,490'
Total Miles	4.128	71.00%	0.551		

(a) 127+45 I-90 = 0+00 PTW (Comparison Equation Only).

(b) Present access is approximately 5.81 miles.

Review Comments & Notes

MAINTENANCE - "22" LINE

Comparison Items	Template A Amount	Template A Points	Template B Amount	Template B Points
Snow Removal:				
Percent of Roadway with Depressed Median.	9.48%	6	33.71%	10
Rock Removal:				
Linear Feet of Cut Ditch	14,353'	14	15,190'	8
Structure Maintenance:				
Linear Feet of Structures.	3,156'	7	3,156'	7
Sanding:				
Linear Feet of Problem Roadway	6,156'	15	6,156'	15
TOTAL POINTS.		42		40

Review Comments & Notes

MAINTENANCE DATA - "22" LINE

SNOW REMOVAL

$$\frac{\text{Total Miles of Depressed Median}}{\text{Total Length of "22" Line}} = \frac{1.876}{5.565} = 33.71\%$$

ROCK REMOVAL

Location	Cut Ditch (Lin.Ft.)
190+00 to 111+30	230'
134+00 to 148+00	1,400'
154+00 to 160+75, Rt & Lt	1,350'
172+10 to 177+50, Rt & Lt	1,080'
189+00 to 192+75, Rt & Lt	375'
205+75 to 210+00	425'
221+00 to 245+00, + 900' Rt	3,100'
245+00 to 258+30	1,330'
262+00 to 270+00, Rt & Lt	1,600'
284+00 to 296+00	1,200'
315+00 to 326+50	1,150'
346+00 to 358+50	1,250'
369+00 to 376+00	700'
TOTAL	15,190'

STRUCTURE MAINTENANCE

Total Linear Feet of Major Structures	1,666'
Total Linear Feet of Retaining Wall	1,490'
TOTAL Linear Feet of Structure Maintenance	3,156'

SANDING

Total Linear Feet of Roadway with 3% Grade or More	4,489.74'
Total Linear Feet of Bridge Deck	1,666.00'
TOTAL Linear Feet of Problem Roadway	6,155.74'

Review Comments & Notes

CONSTRUCTION METHODS - "22" LINE

Comparison Items	Amount	Points
Traffic Control.		8
Earthwork Balance.		7
Simplicity		6
TOTAL POINTS		21

TRAFFIC CONTROL

(Miles)		
Length of Detour Comprised of PTW.	4.128	8
Length of Detour to be Constructed	2.417	8
Length of Detour Separated from Construction	4.128	8
Length of Detour on or Adjacent to Construction	2.417	8
TOTAL POINTS		32

EARTHWORK BALANCE

Does the Total Earthwork Balance?.	Yes	8
Total Number of Balance Points	8	7
Average Distance Between Balance Points (Miles)	0.618	6
TOTAL POINTS		21

SIMPLICITY

Total Linear Feet Major Structures	1,666'	8
Total Linear Feet Retaining Wall	1,490'	6
TOTAL POINTS		14

PART V - Table 12

Review Comments & Notes

CONSTRUCTION METHODS DATA

SIMPLICITY - "22" LINE

MAJOR STRUCTURE DATA

Location	Length	Width	Deck Area (Sq.Ft.)
Henderson Interchange, Eastbound	140'	38'	5,320
Henderson Interchange, Westbound	140'	38'	5,320
167+10 to 172+16	506'	78'	39,468
179+80 to 186+10	630'	78'	49,140
Drexel Interchange, Crossroad	250'	32'	8,000
TOTAL	1,666'		107,248

RETAINING WALL DATA

Location	Linear Feet
169+00	80'
346+50 to 355+00	850'
361+00 to 366+60	560'
TOTAL	1,490'

Review Comments & Notes

SCENIC EVALUATION - "22" LINE

Comparison Items	Template A Amount	Template A Points	Template B Amount	Template B Points
Panorama	*	8	*	14
Total Area Cut Faces (Square Yards)	264,710	14	330,888	6
Number of Areas Where View in Enhanced Over a High Fill.	3	7	3	7
TOTAL POINTS.		29		27

* Value judgment based upon field survey; see Scenic "Basis of Evaluation".

Review Comments & Notes

SCENIC EVALUATION DATA - "22" LINE

Location	Cut Face (Sq.Yd.)
190+00 to 111+30	3,644
134+00 to 148+00	24,622
154+00 to 160+75, Rt & Lt.	20,889
172+10 to 177+50, Rt & Lt.	12,489
189+00 to 192+75, Rt & Lt.	5,600
205+75 to 210+00	11,911
221+00 to 245+00, + 900' Rt.	69,778
245+00 to 258+30	27,822
262+00 to 270+00, Rt & Lt.	29,067
284+00 to 296+00	28,755
315+00 to 326+50	24,311
346+00 to 358+50	26,667
369+00 to 376+00	21,778
376+00 to 406+44.45	11,555
TOTAL	330,888

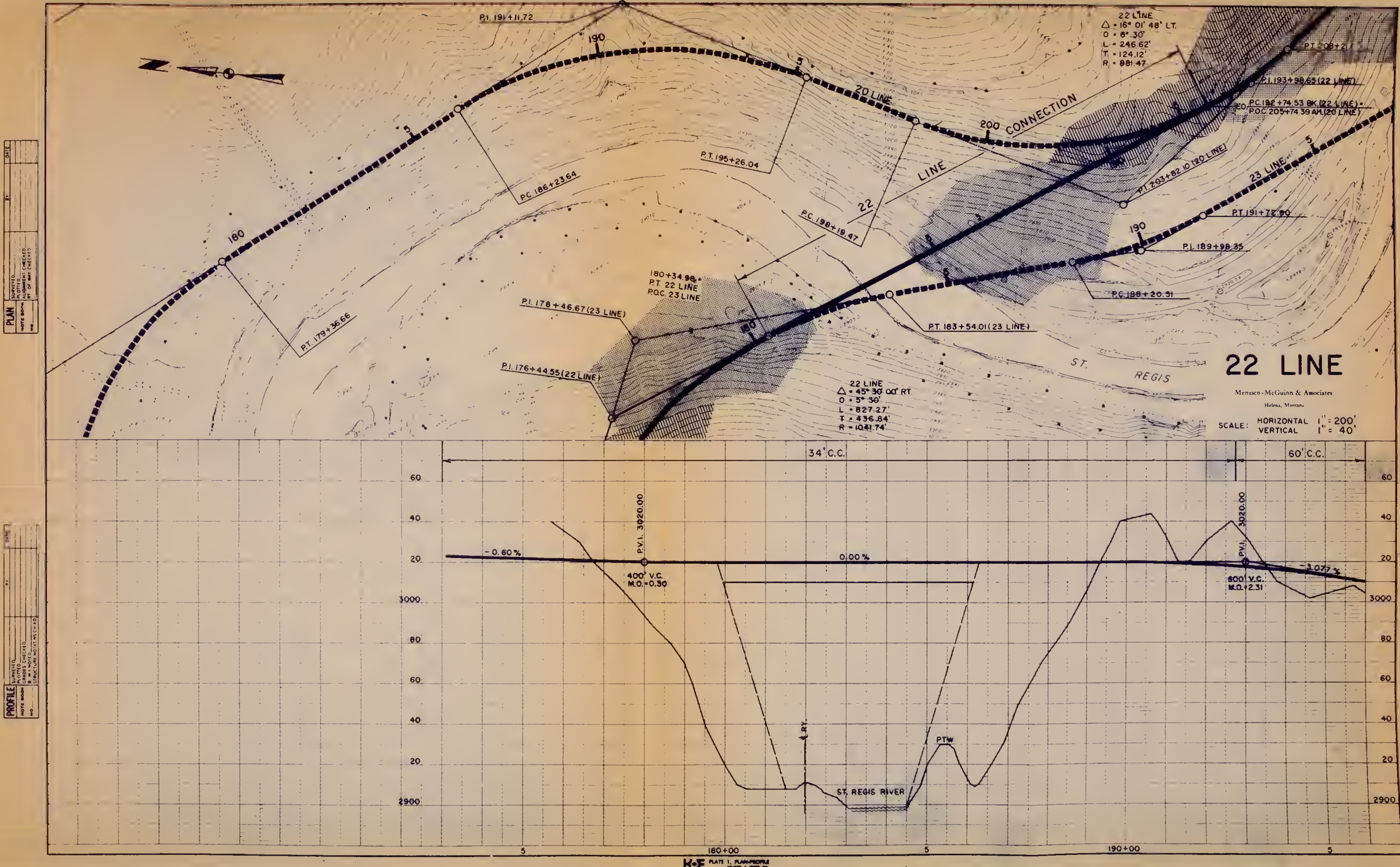
Review Comments & Notes

UTILITIES - "22" LINE

Comparison Items	Points
Versatility of Location*	6

* For explanation of how points were assigned, see "Basis of Evaluation".

Review Comments & Notes



22 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
P.I. 191+11.72
190
5
180
P.C. 186+23.64
P.T. 179+36.66
P.T. 195+26.04
20 LINE
200 CONNECTION
22 LINE
23 LINE
P.C. 198+19.47
180+34.98
P.T. 22 LINE
P.O.C. 23 LINE
P.I. 178+46.67 (23 LINE)
P.I. 176+44.55 (22 LINE)
P.T. 183+54.01 (23 LINE)
P.C. 188+20.51
P.I. 189+98.35
P.T. 191+72.80
P.I. 203+82.10 (20 LINE)
P.C. 192+74.53 BK (22 LINE) = P.O.C. 205+74.39 AH (20 LINE)
P.I. 193+98.65 (22 LINE)
22 LINE
Δ = 16° 01' 48" LT.
D = 6° 30'
L = 246.62'
T = 124.12'
R = 881.47
22 LINE
Δ = 45° 30' 00" RT.
D = 5° 30'
L = 827.27'
T = 436.84'
R = 1041.74'
ST. REGIS
34' C.C.
60' C.C.
-0.60 %
0.00 %
-3.077 %
P.V.I. 3020.00
400' V.C.
M.O. = 0.30
P.V.I. 3020.00
600' V.C.
M.O. = 2.31
PTW
ST. REGIS RIVER
60
40
20
3000
80
60
40
20
2900
180+00
190+00
PLAN
PROFILE
K+E PLATE 1, PLAN-PROFILE

Part VI
"23" Line

PART VI

"23" LINE

A. INTRODUCTION

The "23" Line study was undertaken to locate an alignment that would have the least amount of conflict with the canyon. It is felt that anything but a narrow barrier median - type cross section would not be consistent with this purpose. Therefore, the "23" Line study is based on 34 - foot centers (Template A) throughout the project.

B. HORIZONTAL ALIGNMENT

Beginning at Station 130+00 and proceeding east, a 4-degree curve at P.I. Station 139+17.60 provides a transition from the 2-degree, 45-minute curve in the Henderson interchange area and sets the alignment up on the sidehill.

The nose at Station 157+00, projecting as it does across the general alignment, creates a problem for both the horizontal and vertical alignments. The horizontal configuration of the nose is much too sharp to allow a roadway with a 7-degree, 30-minute curve to go around the nose. The difference in elevation between the PTW and a logical crossing of the ridge is 200 feet. There are several possible solutions to this problem. The solution chosen by the designer at this location sets the trend of design through the remaining section of canyon. The designer may elect to cut the roadway through the nose and hold the vertical alignment to very little rise; or, he may elect to "roll" the roadway over this nose. The choice of a combination of sharp horizontal and vertical curves was considered, but this produced a very undesirable driving situation.

Our solution to this problem is to locate the roadway high on the sidehill and cross the ridge with an 800-foot vertical curve that has an algebraic difference of only 2.666. The horizontal curve at this location is only 4 degrees. Our concept requires the crossing of the St. Regis River and the railroad with a bridge from Station 167+00 to Station 172+00. The roadway proceeds through another nose whose ridgeline is at Station 174 + 50 with no vertical curve and only a 5-degree, 30-minute horizontal curve to the right. After crossing this nose, the roadway again crosses the railroad and the river on a bridge from Station 180+00 to Station 186+50.

The two double structures over the river and railroad are costly, but they afford a good horizontal alignment.

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As the "23" Line crosses the river the second time, the grade is -4 percent. This is done to get the alignment down to the canyon floor. A 5-degree, 30-minute horizontal curve to the left is negotiated. The roadway again crosses the St. Regis River from Station 196+75 to Station 200+25, and at Station 202+75 through Station 207+00. These two crossings are required because the reversing nature of the river is too sharp to be negotiated by horizontal curves of 7 degrees, 30 minutes or less. The alignment could have been accomplished by including more horizontal curvature and an 800-foot long channel change that would have shortened the river; however, it is our opinion that two structures and a channel change which places the river into its original channel, as well as adding length to the river, is the best solution.

From Station 210+00 ahead to the Drexel interchange at Station 295+00, the design is typical canyon design. The roadway generally parallels the St. Regis River and, as a result of the natural meanderings of the river, the roadway is a series of reversing 7-degree and 7-degree, 30-minute curves. The gradeline was held high to minimize the cut and also to minimize the waste of embankment.

Computer earthwork runs indicate that waste for the "23" Line will be 801,000 cubic yards. This would require waste to be hauled and spread in the interchange areas, or that all fill backslopes be flattened as much as possible. Any flattening of backslopes would increase the fill prism and, in turn, would cover more of the natural vegetation.

The existing bridge across the St. Regis River from the PTW to the Drexel Substation will be retained by the "23" Line design. Access from the interstate to Drexel will be via the Drexel interchange at Station 295+00, onto the PTW, and then crossing to the river on the existing bridge at Station 279+00.

The Drexel interchange is proposed at Station 295+00 as an interstate under, crossroad over, "diamond" interchange. This arrangement allows the entrance and exit ramps on the east - half of the interchange to be placed on the sidehill with very little cut or fill

From the Drexel interchange east, the roadway is again placed parallel to the river. The distance between the meanderings of the river lengthen in this portion of the project which allows more tangent distance. The longer tangent also allows the curves to be 7 degrees at Station 305+15.98; 6 degrees at Station 319 + 91.82; 7 degrees at Station 337 + 26.05; 7 degrees at Station 347+00.66; 6 degrees at Station 362+65.80; and 4 degrees at Station 376 + 76.79. The last curve and the tangent were designed to tie into the project ahead. We can adjust the grade and the alignment at Station 395+80.38 to meet a small change in the design ahead.

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The "23" Line has a good horizontal alignment from Station 130 + 00 through Station 200 + 00. Although it is not a tangent through this portion of the project, the lower degree of curves (4 degrees and 5 degrees) present a pleasing transition into the canyon on the eastbound and out of the canyon on the westbound roadway.

C. VERTICAL ALIGNMENT

Beginning at Station 130+00, the alignment starts a climb to a sidehill location with a +4.66 percent grade. This increase in elevation is due to the high nose at Station 157+00. The +4.66 percent grade is only 200 feet long due to the vertical curve placement at Station 139+00. The upgrade is reduced from +4.66 percent to +1.474 percent. The reason for the deviation from a water grade of the St. Regis River, as stated before, is the nose at Station 157+00. The 800-foot vertical curve with an algebraic difference of only 2.666 is a reasonable solution to this problem. The vertical grade increases to -4 percent as it crosses the railroad and river for the second time to place the alignment at the canyon floor.

The vertical alignment is held to an approximate water grade from Station 194+00 through Station 324+00 with grades averaging approximately one percent throughout this section. At Station 324 + 00, a +3.65 percent grade is introduced to "roll" the grade over the nose at the Ward Creek access point. Again, care was taken to prevent an unacceptable vertical-horizontal combination of steep vertical change at a sharp horizontal curve (7 degrees).

The grade at Station 361+00 is a -4.2 percent to bring the alignment down close to the PTW elevation and remains at this elevation to the east end of the project.

D. ROADWAY CROSS SECTION

As discussed in Section "A", the roadway section for the "23" Line will be narrow median, 34-foot center-to-center, for the entire project length, except for the Henderson interchange area.

E. ANNUAL COST

The total annual cost for the "23" Line is $1,577,271. The construction cost estimate is $6,161,574. The major reason for this high construction cost is the two major bridges across the St. Regis River. The operating costs for the "23" Line are

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$1,126,218 which is relatively low due to its short length. Maintenance costs for the paving amount to $21,573.

F. RIVER ACCESS AND CONFLICT

The "23" Line provides 2.301 miles of river access by virtue of retaining the PTW from the beginning of the project through Station 185+00. At Station 169+00, a small amount of reconstruction around the toe of fill at the bridge is required to extend the usage of the PTW.

One area of river conflict occurs right of Station 186+00 where the toe of the bridge fill conflicts with the river and requires a retaining wall.

At Station 198+00 to Station 205+50, the "23" Line crosses the river twice. It is proposed to relocate the river back into its original channel at this location.

The ramps at Ward Creek create a major river conflict and require extensive use of retaining walls. It is anticipated that final design may be able to ease this situation somewhat.

G. MAINTENANCE

The paving maintenance costs are covered under "Annual Cost". The "23" Line requires additional sanding as a result of the 4,212 linear feet of structures. The snow removal for the "23" Line was considered to be the least desirable by virtue of its narrow median design not providing snow storage.

Rock removal from cut ditches amounts to 20,265 linear feet.

H. CONSTRUCTION METHODS

The "23" Line will require 3.811 miles of detour to be constructed. Only 2.301 miles of the PTW can be used as a detour during construction. 3.107 miles of the detour will have to be on or directly adjacent to the construction area.

The "23" Line has an excess cut situation due to its location on the canyon floor. The grade cannot be held high enough to effectively balance the earthwork due to the close proximity to the river.

The "23" Line has 2,412 linear feet of major structures where it crosses the river and railroad. These structures are 100 feet high at these locations and must be considered as complicated construction projects.

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The 6,650 linear feet of retaining walls will require special design which, in turn, adds complication to the construction of the project. The "23" Line requires 3,073,683 cubic yards of excavation.

I. SCENIC EVALUATION

The "23" Line is elevated from Station 130+00 to Station 230+00 and affords a good panorama of the canyon in this area as shown in Photos No. 4 and No. 5 of Appendix A. After the alignment drops down to the canyon floor, the close proximity of the railroad and its associated power poles results in a view as shown in Photo No. 2 of Appendix A.

J. UTILITIES

The "23" Line will require the relocation of 143 trunk telephone poles and eight power poles. The cost of relocating these poles was included in the "Annual Cost". The problem arrises as to the locations available to relocate pole lines and the maintenance access to the lines after relocation. The "23" Line affords access and location for present and future utilities while it is holding its elevated alignment (Station 130+00 to Station 230+00), but after returning to the canyon floor, the alignment itself uses the available space that could be provided for utilities. From the Drexel interchange east, all alignments are along the PTW, but two possible access points are provided at Ward Creek access and the Forest Service access points.

K. DESIGN STANDARDS

Design standards for the "23" Line are as indicated in Part I-C.

L. TRAFFIC

Traffic movements and counts are the same as called for in Part I-E.

M. RIGHT-OF-WAY

The right-of-way requirements for the "23" Line are as delineated in Part I-F.

N. STRUCTURES

(1) Henderson Interchange

Refer to Part II - Henderson Interchange.

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(2) Station 167+10 to Station 172+16

A single four-lane structure is proposed at this location, having a width of 78 feet and a total length of 506 feet, giving a total deck area of 39,468 square feet. The structure will incorporate three spans of approximately 140 feet, 226 feet, and 140 feet. The center span of 226 feet will span the relocated river access road, the St. Regis River, and the railroad.

General features of this structure, such as type of construction, stringer spacing, pier type, and foundations, are similar to those presented for the structure between Stations 166+54 and 172+26 in Part IV - "21" Line. Stringer depths would be in the same order of magnitude; however, they may be somewhat shallower in the shorter 140-foot end spans. The piers will have little or no skew.

(3) Station 180+00 to Station 186+40

This structure will be a single four-lane bridge, having a width of 78 feet between curbs and a total length of 640 feet, giving a total deck area of 49,920 square feet.

With exception of the pier skew angles and the alignment, this structure will be almost identical to that proposed between Stations 179+80 and 186+10 in Part V - "22" Line. The exception is that the pier skew angles will be somewhat larger and the north end of this structure will be on a curve.

(4) Station 196+75 to Station 200+05

This bridge shall be a single four-lane structure, having a width of 78 feet and a total length of approximately 330 feet with a total deck area of 25,740 square feet. The structure shall consist of three spans of 100 feet, 130 feet, and 100 feet respectively.

General construction characteristics such as type of deck construction, number and spacing of stringers, location of stringer hinges, type of piers, and type of foundation are similar to those proposed for the structure between Stations 166+54 and 172+26 in Part IV - "21" Line.

(5) Station 202+90 to Station 207+05

A single four-lane structure is proposed at this location, having a width of 78 feet and a total length of 415 feet, with a total deck area of 32,370 square feet. The structure shall consist of three spans of 85 feet, 170 feet, and 160 feet.

This bridge, with exception of girder depths, pier skews, and alignment (this bridge is on a curve), will be similar to

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that proposed for the structure between Stations 166+54 and 172+26 in Part IV - "21" Line.

O. GEOLOGY

The "23" Line geology is the same as all other lines studied and is discussed in Part I-F.

P. DRAINAGE

In the Henderson interchange area, all alignments are similar. The embankment for Ramp No. 1 creates a pocket at Station 105+50. Transporting water that will accumulate to the river will require 280 feet of 24-inch drain pipe.

The largest drainage on the "23" Line occurs at Station 134+00, where the roadway crosses Twelvemile Creek. Two 9-foot high, 15-foot wide cast-in-place reinforced concrete boxes 212 feet long will be needed to adequately transport the 40,000 acres of drainage under the roadway at a 30-degree skew left to the St. Regis River.

At Station 152+50, an isolating fill on the left traps 96 acres of drainage and requires 266 feet of 24-inch drain pipe. For more than a mile, no additional drainage is required, due to the river crossings.

At Station 217+50, another isolating fill must be drained. This fill traps 80 acres and requires 240 feet of 24-inch drain pipe.

At Station 235+50, the fill traps 40 acres of drainage. 194 feet of 24-inch drain pipe is needed to transport this water to the river.

At Station 248+00, the left embankment hinge point is in a 6-foot fill. This isolating fill traps 602 acres. 152 feet of 54-inch drain pipe will transport this water to the river.

Ninety acres drain into a former river channel at Station 272+50. 130 feet of 24-inch drain pipe will be needed to drain this area.

At Station 280+00 directly across from Drexel, a draw draining 506 acres is undercut by the left-side excavation. An inlet in the undisturbed channel with 254 feet of 30-inch drain pipe extends to an inlet in the left cut ditch, which in turn connects to 148 feet of 48-inch drain pipe will be required for this drainage.

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Approximately 2,400 feet east of Drexel (Station 302 + 50), 244 feet of 24 - inch drain pipe will drain a former river channel.

At Station 322 + 00, draining a vertical curve sag requires 146 feet of 30-inch drain pipe and one drop inlet.

At Stations 332+00 and 352+00, small natural drainages occur through short sections of fill. 170 feet and 205 feet respectively of 24-inch drain pipe and one inlet each will be required at these locations.

Between Stations 366+00 and 370+00, 314 acres drain toward the proposed highway. For this estimate, a 500 linear foot interceptor ditch was used above the top of cut line from Station 366+00 to an inlet at Station 170+00. This inlet is connected to an inlet in the left roadway cut ditch by 200 feet of 30-inch drain pipe. The water then crosses the roadway to the river through 144 feet of 42-inch drain pipe.

At Station 388 + 00, another natural drainage is undercut. This gulch drains 760 acres. Therefore, for slope protection, flow is intercepted with an inlet in the undisturbed channel. This inlet is connected to an inlet in the left roadway ditch by 60 feet of 36-inch drain pipe. The water then crosses the roadway through 144 feet of 54-inch drain pipe.

Q. HIGHWAY RATING INDEX

The data used to develop the rating index for this line are found on the following pages.

Review Comments & Notes

HORIZONTAL ALIGNMENT - "23" LINE

Comparison Items	Amount	Points
Total Length of Comparison:		
Feet.	29,580.39'	
Miles	5.602	6
Total Number of Curves	19	
Curve Frequency Per Mile	3.39	2
Maximum Degree of Curvature.	7.50°	6
Average Degree of Curvature.	6.17°	5
Average Length of Curve.	778.77'	6
Average Deflection Per Curve	45.08°	6
Total Deflection Over Comparison	856.49°	6
Average Deflection Per Mile.	152.89°	6
Total Feet Curvilinear Roadway	14,796.70'	6
Percent of Curvilinear Roadway	50.0%	6
Average Tangent Between Curves	694.70'	6
Total Number of Structures	12	2
TOTAL POINTS.		63

Review Comments & Notes

HORIZONTAL ALIGNMENT DATA - "23" LINE

Curve Number	Deflection Angle	Degree of Curve	Length	Distance P.C. to P.T.
1*	62.18°	2.75°	2,260.98'	
				685.56'
2	37.52°	4.00°	938.12'	
				876.83'
3	38.35°	4.00°	958.80'	
				1,002.95'
4	63.05°	5.50°	1,146.30'	
				466.50'
5	19.38°	5.50°	352.29'	
				1,053.25'
6	34.54°	7.50°	460.53'	
				323.18'
7	52.54°	7.50°	700.58'	
				330.31'
8	25.34°	7.00°	362.00'	
				373.24'
9	60.23°	7.00°	860.45'	
				471.83'
10	85.39°	7.50°	1,138.52'	
				282.88'
11	73.92°	7.50°	985.61'	
				671.39'
12	76.41°	7.50°	1,018.74'	
				374.85'
13	38.41°	6.00°	640.15'	
				1,104.00'
14	26.36°	7.00°	376.56'	
				849.68'
15	49.52°	6.00°	825.27'	
				1,170.44'
16	24.66°	7.00°	352.31'	
				297.91'
17	63.18°	7.00°	902.50'	
				1,011.66'
18	22.26°	6.00°	370.68'	
				1,124.67'
19	8.25°	4.00°	206.20'	
Total	856.49°	117.23°	14,796.70'	10,829.16'
Average	45.08°	6.17°	778.77'	601.62'

Percent of Curvilinear Roadway = $\frac{14,796.70}{29,580.39}$ = 50.0%

Average Deflection Per Mile = $\frac{856.49}{5.602}$ = 152.89°

* Henderson Interchange Area.

PART VI - Table 2

Review Comments & Notes

VERTICAL ALIGNMENT - "23" LINE

Comparison Items	Amount	Points
Total Length of Comparison:		
Feet.	29,580.39'	
Miles	5.602	6
Total Number of Vertical Curves.	13	
Curve Frequency Per Mile	2.32	4
Average Length of Vertical Curve	800.00'	
Average Algebraic Difference	3.029%	
K Factor(1)	264.11	9
Maximum Grade in Comparison.	4.660%	9
Average Grade in Comparison.	2.049%	8
Percentage of Roadway with:		
5% Grade or More.	0.0%	9
3% - 5% Grade	16.4%	2
2% - 3% Grade	8.6%	9
Less than 2% Grade.	75.0%	10
TOTAL POINTS.		66

(1) K = Average length of vertical curve divided by average algebraic difference.

Review Comments & Notes

VERTICAL ALIGNMENT DATA - "23" LINE

Sta. VPI	Distance VPI-VPI	Per Cent Grade	G2-G1	Length V.C.	K Factor
100+00					
	1,457.5'	+1.438%			
114+57.5			3.444	800'	232
	1,542.5'	-2.006%			
130+00			6.666	800'	120
	1,000'	+4.660%			
140+00			3.186	800'	251
	1,000'	+1.474%			
150+00			0.592	800'	1351
	1,000'	+2.066%			
160+00			2.666	800'	300
	1,900'	-0.600%			
179+00			3.391	800'	235
	1,600'	-3.991%			
195+00			2.528	800'	316
	5,200'	-1.463%			
247+00			0.463	800'	1727
	4,000'	-1.000%			
287+00			0.375	800'	2133
	3,800'	-0.625%			
325+00			4.275	800'	187
	1,300'	+3.650%			
338+00			4.900	800'	163
	2,400'	-1.250%			
362+00			2.950	800'	271
	950'	-4.200%			
371+50			3.935	800'	203
	2,430.4'	-0.265%			
395+80.4					
Total		28.686%	39.377	10,400'	7493.27
Average		2.049%	3.029	800'	264.11

Review Comments & Notes

ROADWAY CROSS SECTION - "23" LINE

Comparison Items	Template A Amount	Template A Points
34' Center-Center, Miles	5.075	
60' Center-Center, Miles	0.527	
34' Center-Center	90.59%	4
60' Center-Center	9.41%	4
TOTAL POINTS		8

Review Comments & Notes

ROADWAY CROSS SECTION DATA - "23" LINE

	34' Center-Center (Miles)	60' Center-Center (Miles)
Template A: (Only)		
*100+00 to 127+45.46		0.527
127+45.46 to 395+80.39	5.075	
Total	5.075	0.527
Per Cent	90.59%	9.41%

* Henderson Interchange

Review Comments & Notes

COST ESTIMATE - "23" LINE

	CAPITAL RECOVERY FACTOR		TEMPLATE A 34' Ctr-Ctr Only	
	Years	Interest	Const. Cost	Annual Cost
Guard Rail	20	0.0872	$ 296,338	$ 25,836
Base, Surfacing & Pavement	20	0.0872	996,571	86,886
Grading, Earthwork & Channel Change	40	0.0665	1,844,210	122,569
Drainage	40	0.0665	155,190	10,314
Retaining Walls.	50	0.0634	108,000	6,852
Major Structures	50	0.0634	2,604,336	165,230
Cantilever Section . . .	50	0.0634	-0-	-0-
Utilities.	50	0.0634	79,500	5,044
Rest Area.	20	0.0872	28,685	2,500
Traffic Control.	20	0.0872	48,744	4,249
TOTAL CONSTRUCTION COST.			$6,161,574	
Sub-Total Annual Cost				$ 429,480
Percentage of Construction Cost Differential			156.5%	
Maintenance:				
Interstate 4-Lane @ $3,000/Mile . . .				16,884
Crossroad & Interchange Ramps @ $1,500/Mile				4,689
Operating Cost				1,126,218
TOTAL ANNUAL COST.				$1,577,271

PART VI - Table 7

Review Comments & Notes

RIVER ACCESS & CONFLICT - "23" LINE

Comparison Items	Amount	Points
Total River Access, Miles.	2.301	4
Percent of Present Access Retained	40%	4
Present Access Road (PTW) Relocated, Miles.	0.118	10
Minor River Conflict, Feet(1).	1,600'	6
Major River Conflict, Feet(2).	1,800'	4
River Improvement(3)	900'	10
River Access Continuous Between Henderson and Drexel.	No	3
TOTAL POINTS.		41

(1) Encroachment on present river bed not requiring channel change or retaining wall.

(2) Encroachment on present river bed requiring undesirable channel change or retaining wall.

(3) Desirable channel change, flood plain improvement, etc.

Review Comments & Notes

RIVER ACCESS & CONFLICT DATA

"23" LINE, TEMPLATE A

Items	1	(b) 2	3	4	5
(a) PTW Stations	Amt. River Access	Percent Access Main-tained	Total Constr. Items 1 & 2	Amt. Minor Conflict	Amt. Major Conflict
Henderson Interchange	2,696'	8.78%			
0+00 to 48+25	4,825'	15.80%			
48+25 to 54+50	625'	2.04%	625'		
54+50 to 85+50	3,100'	10.10%			
85+50 to 90+35				150'	150'
90+35 to 112+35					150'
112+35 to 182+00				450'	
182+00 to 191+00	900'	2.93%			
Beyond Drexel				1,000'	1,500'
Total Feet	12,146'	40.00%	625'	1,600'	1,800'
Total Miles	2.301	40.00%	0.118		

(a) 127+45 I-90 = 0+00 PTW (Comparison Equation Only).

(b) Present access is approximately 5.81 miles.

NOTE: Between Stations 198+00 and 205+00 (I-90), there is a 900' return to the original natural river bed.

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MAINTENANCE - "23" LINE

Comparison Items	Template A Amount	Template A Points
Snow Removal:		
Percent of Roadway with Depressed Median.	9.41%	4
Rock Removal:		
Linear Feet of Cut Ditch.	20,265'	4
Structure Maintenance:		
Linear Feet of Structures	4,212'	4
Sanding:		
Linear Feet of Problem Roadway. . . .	7,263'	8
TOTAL POINTS.		20

Review Comments & Notes

MAINTENANCE DATA - "23" LINE

SNOW REMOVAL

$$\frac{\text{Total Miles of Depressed Median}}{\text{Total Length of "23" Line}} = \frac{0.527}{5.602} = 9.41\%$$

ROCK REMOVAL

Location	Cut Ditch (Lin.Ft.)
109+00 to 111+30	230'
134+00 to 148+00	1,400'
154+00 to 160+75, Rt & Lt	1,350'
172+10 to 177+50, Rt & Lt	1,080'
190+50 to 195+50	500'
207+00 to 214+50	750'
225+00 to 231+75	675'
238+00 to 245+00	700'
250+00 to 259+50	950'
274+00 to 295+00, Rt & Lt	4,200'
305+00 to 310+00	500'
310+00 to 322+50, Rt & Lt	2,500'
335+50 to 342+75	725'
342+75 to 350+00, Rt & Lt	725'
355+00 to 395+80.38	4,080'
TOTAL	20,265'

STRUCTURE MAINTENANCE

Total Linear Feet of Major Structures	2,412'
Total Linear Feet of Retaining Walls	1,800'
TOTAL Linear Feet of Structure Maintenance	4,212'

SANDING

Total Linear Feet of Roadway with 3% Grade or More	4,851.18'
Total Linear Feet of Bridge Deck	2,412.00'
TOTAL Linear Feet of Problem Roadway	7,263.18'

Review Comments & Notes

CONSTRUCTION METHODS - "23" LINE

Comparison Items	Amount	Points
Traffic Control.		4
Earthwork Balance.		3
Simplicity		3
TOTAL POINTS		10

TRAFFIC CONTROL

(Miles)		
Length of Detour Comprised of PTW.	2.301	4
Length of Detour to be Constructed	3.811	4
Length of Detour Separated from Construction	3.693	4
Length of Detour on or Adjacent to Construction	3.107	4
TOTAL POINTS		16

EARTHWORK BALANCE

Does the Total Earthwork Balance?.	No	3
Total Number of Balance Points	4	3
Average Distance Between Balance Points (Miles)	1.120	4
TOTAL POINTS		10

SIMPLICITY

Total Linear Feet Major Structures	2,412'	4
Total Linear Feet Retaining Wall	1,800'	4
TOTAL POINTS		8

Review Comments & Notes

CONSTRUCTION METHODS DATA

SIMPLICITY - "23" LINE

MAJOR STRUCTURE DATA

Location	Length	Width	Deck Area (Sq.Ft.)
Henderson Interchange, Eastbound	140'	38'	5,320
Henderson Interchange, Westbound	140'	38'	5,320
167+10 to 172+16	506'	78'	39,468
180+00 to 186+40	640'	78'	49,920
196+75 to 200+05	330'	78'	25,740
202+90 to 207+05	406'	78'	31,668
Drexel Interchange, Crossroad	250'	32'	8,000
TOTAL	2,412'		165,436

RETAINING WALL DATA

Location	Linear Feet
169+00	80'
186+00	160'
206+85	150'
346+50 to 355+00	850'
361+00 to 366+60	560'
TOTAL	1,800'

Review Comments & Notes

SCENIC EVALUATION - "23" LINE

Comparison Items	Template A Amount	Template A Points
Panorama	*	4
Total Area Cut Faces (Square Yards). . . .	312,133	10
Number of Areas Where View is Enhanced Over a High Fill.	0	3
TOTAL POINTS.		17

* Value judgment based upon field survey; see Scenic "Basis of Evaluation".

Review Comments & Notes

SCENIC EVALUATION DATA - "23" LINE

Location	Cut Face (Sq.Yd.)
109+00 to 111+30	3,644
134+00 to 148+00	24,622
154+00 to 160+75, Rt & Lt.	20,889
172+10 to 177+50, Rt & Lt.	12,489
190+50 to 195+50	3,022
207+00 to 214+50	11,733
225+00 to 231+75	11,644
238+00 to 245+00	15,111
250+00 to 259+50	25,333
274+00 to 295+00, Rt & Lt.	60,089
305+00 to 310+00	10,667
310+00 to 322+50, Rt & Lt.	27,600
326+50 to 330+80	2,222
332+00 to 335+50	2,667
335+50 to 342+75	13,111
342+75 to 350+00, Rt & Lt.	16,400
355+00 to 395+80.38	54,533
TOTAL	312,133

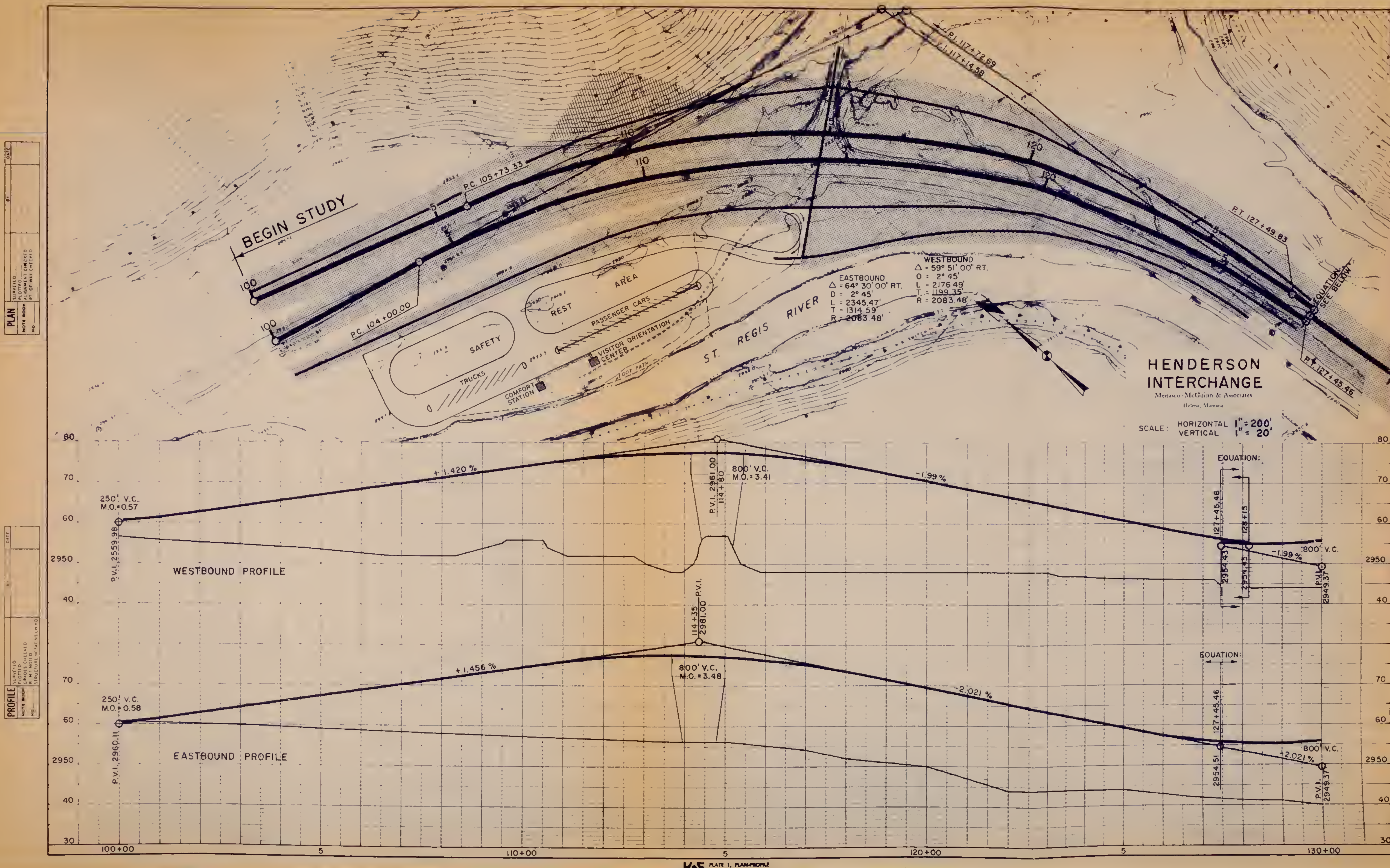
Review Comments & Notes

UTILITIES - "23" LINE

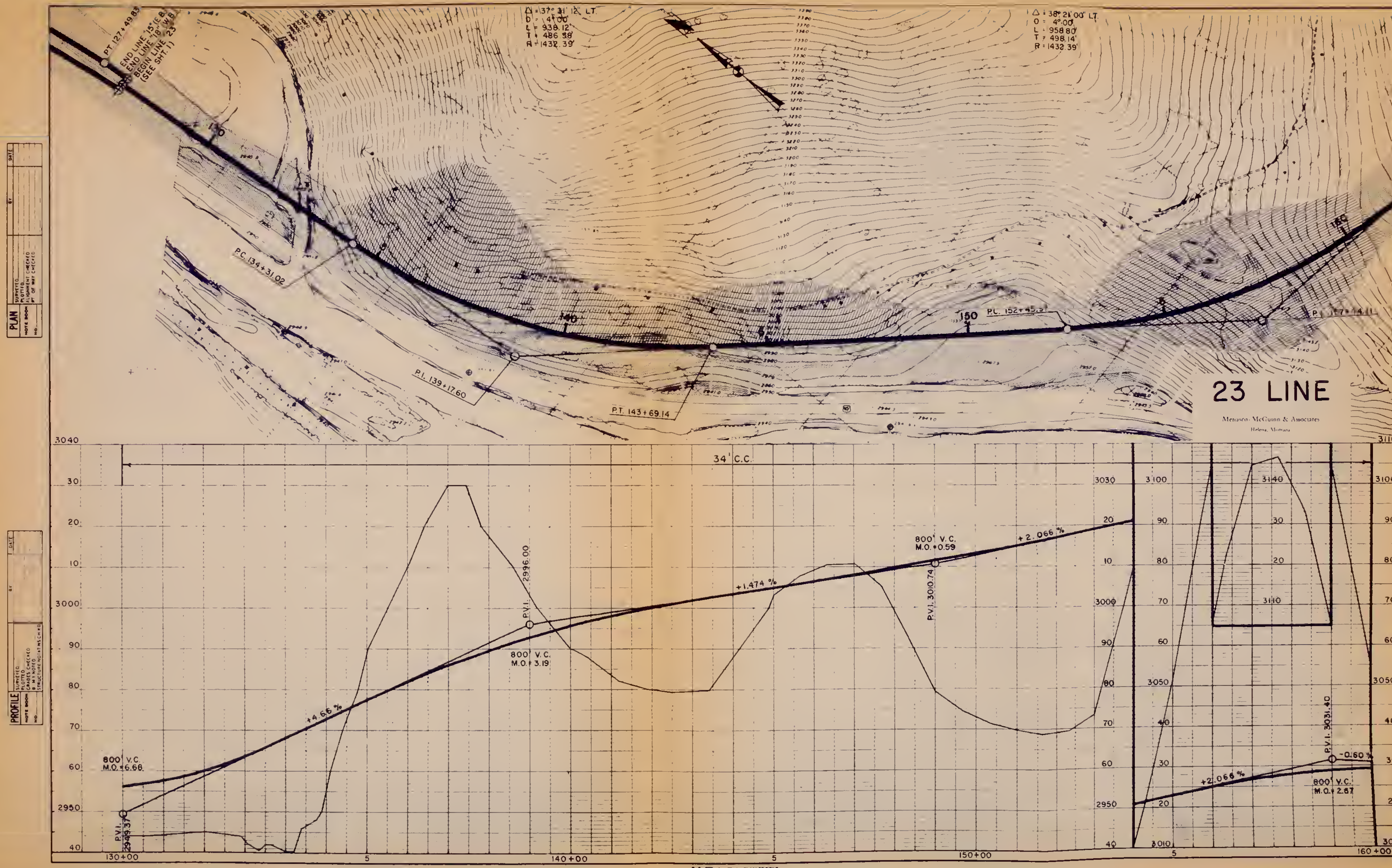
Comparison Items	Points
Versatility of Location*	3

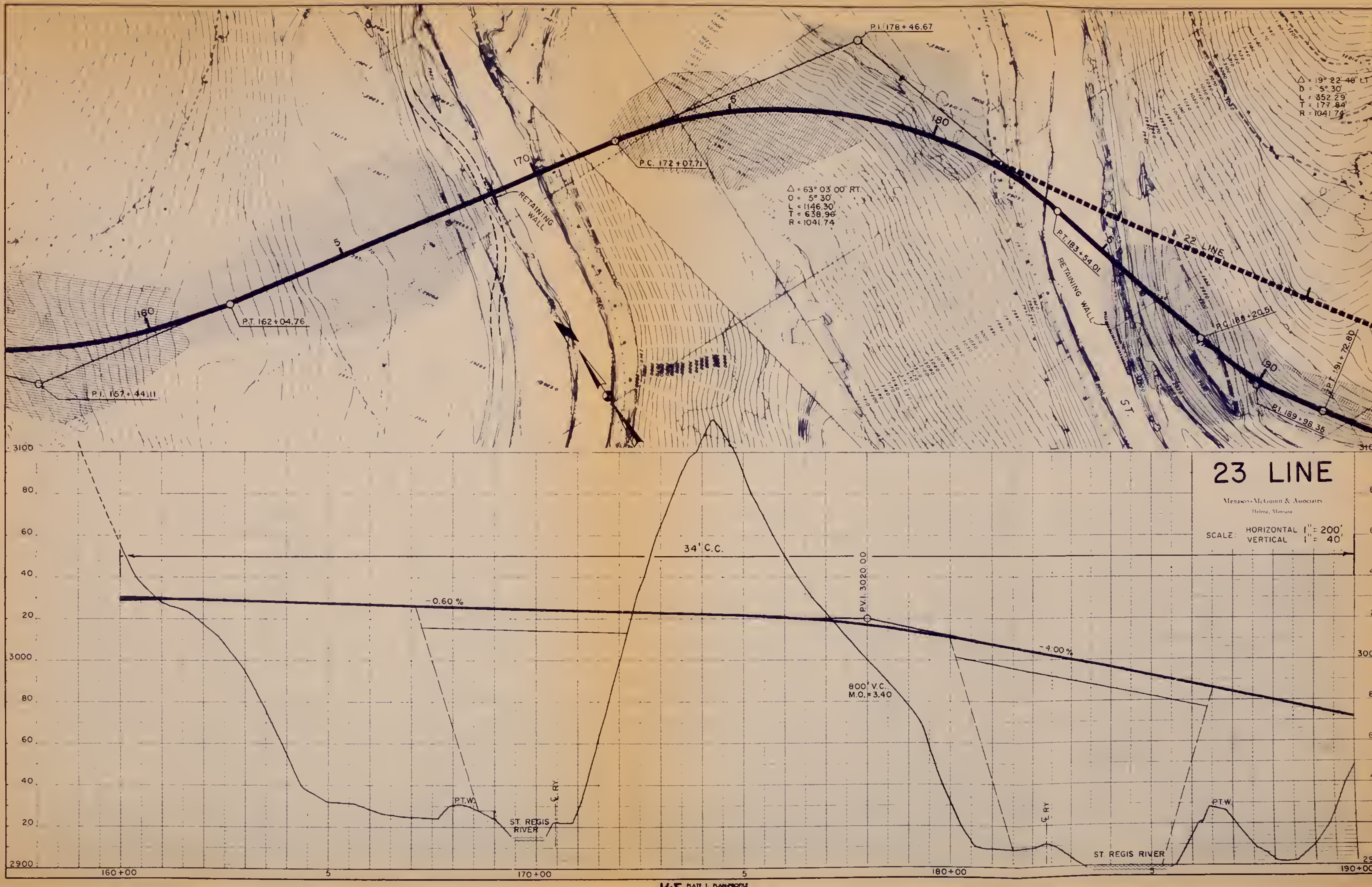
* For explanation of how points were assigned, see "Basis of Evaluation".

Review Comments & Notes

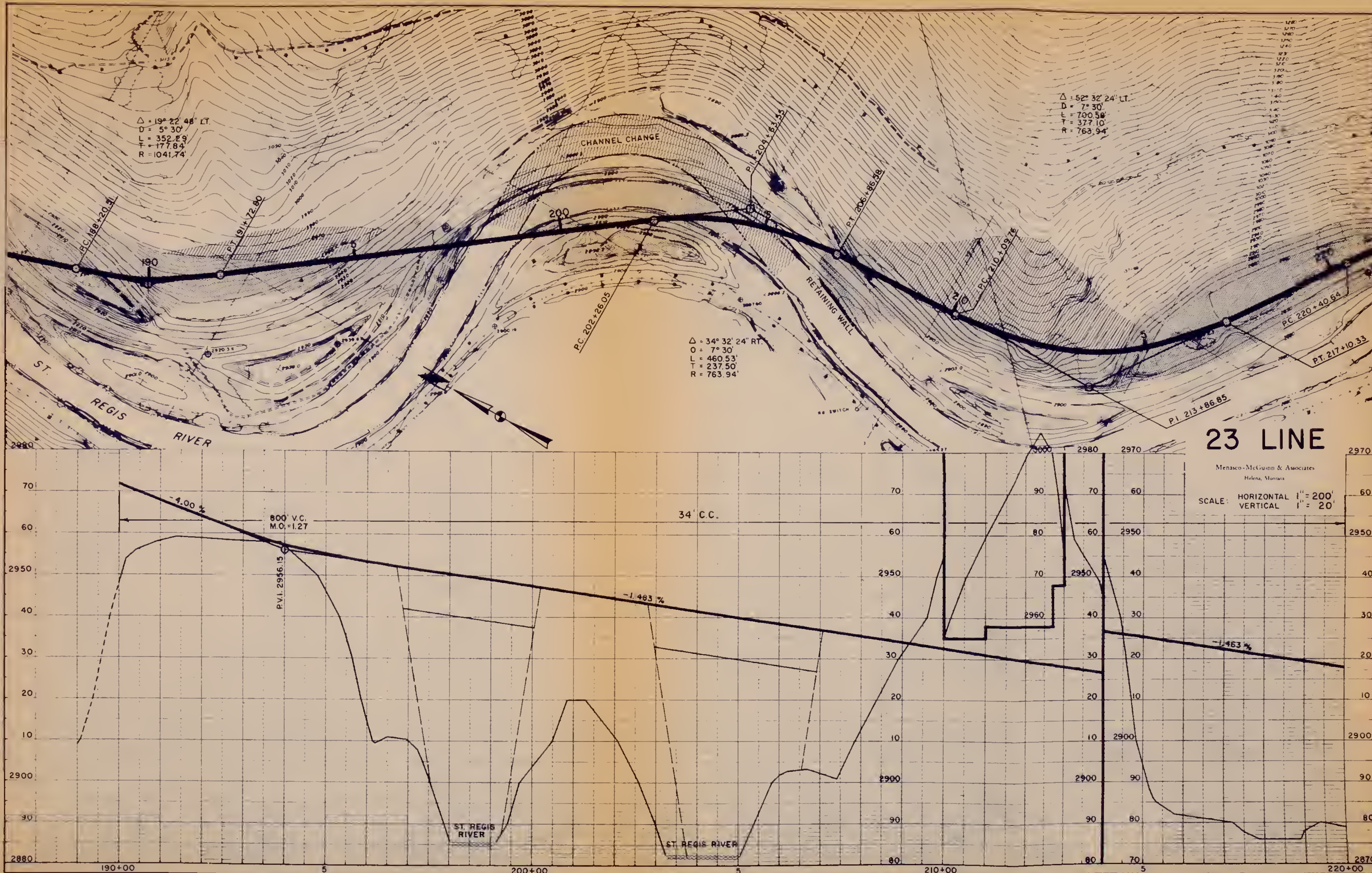


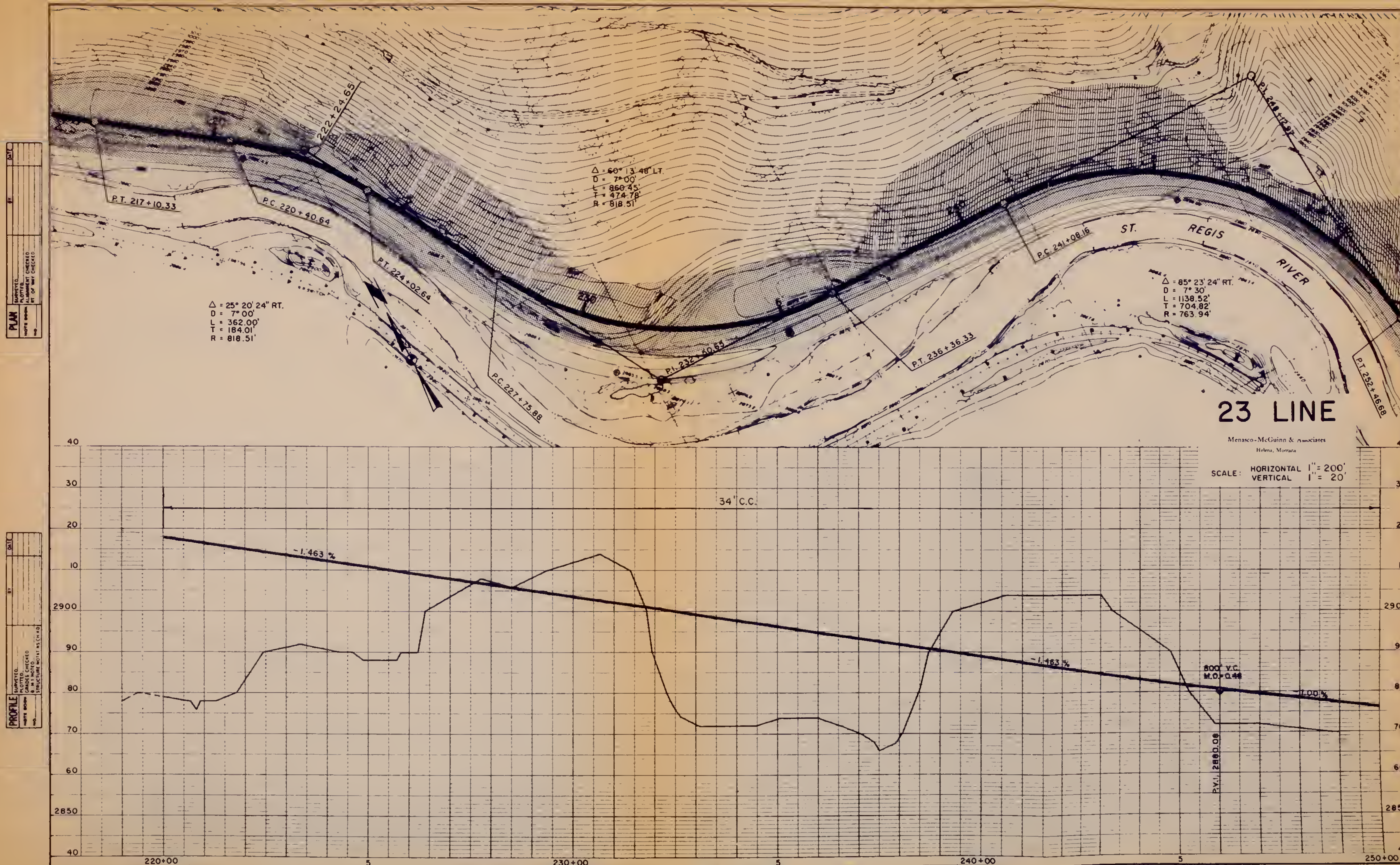
BEGIN STUDY
P.C. 105+73.33
P.C. 104+00.00
P.I. 117+72.69
P.I. 117+14.58
P.T. 127+49.83
P.T. 127+45.46
EQUATION SEE BELOW
SAFETY REST AREA
TRUCKS
PASSENGER CARS
VISITOR ORIENTATION CENTER
COMFORT STATION
FOOT PATH
ST. REGIS RIVER
EASTBOUND
Δ = 64° 30' 00" RT.
D = 2° 45'
L = 2345.47'
T = 1314.59'
R = 2083.48'
WESTBOUND
Δ = 59° 51' 00" RT.
D = 2° 45'
L = 2176.49'
T = 1199.35'
R = 2083.48'
HENDERSON INTERCHANGE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 20'
WESTBOUND PROFILE
250' V.C.
M.O. = 0.57
P.V.I. 2559.98
+1.420 %
P.V.I. 2961.00
114+80
800' V.C.
M.O. = 3.41
-1.99 %
EQUATION:
127+45.46
128+15
2954.43
2954.43
800' V.C.
P.V.I.
2949.37
EASTBOUND PROFILE
250' V.C.
M.O. = 0.58
P.V.I. 2960.11
+1.456 %
114+35
2961.00
P.V.I.
800' V.C.
M.O. = 3.48
-2.021 %
EQUATION:
127+45.46
2954.51
800' V.C.
-2.021 %
P.V.I.
2949.37
100+00
110+00
120+00
130+00
K+E PLATE 1, PLAN-PROFILE
PLAN
PROFILE


23 LINE
Menasco-McGuinn & Associates
Helena, Montana
Δ = 37° 31' 12" LT
D = 4° 00'
L = 938.12'
T = 486.38'
R = 1432.39'
Δ = 38° 21' 00" LT
D = 4° 00'
L = 958.80'
T = 498.14'
R = 1432.39'
P.T. 127+49.83
END LINE "15" (E.B.)
END LINE "18" (W.B.)
BEGIN LINE "23"
(SEE SHT. 1)
P.C. 134+31.02
P.I. 139+17.60
P.T. 143+69.14
P.C. 152+45.31
P.I. 157+14.11
140
150
160
34' C.C.
800' V.C.
M.O. +6.68
P.V.I. 2949.37
+4.66 %
P.V.I. 2996.00
800' V.C.
M.O. +3.19
+1.474 %
800' V.C.
M.O. +0.59
P.V.I. 3010.74
+2.066 %
+2.066 %
P.V.I. 3031.40
-0.60 %
800' V.C.
M.O. +2.67
130+00
140+00
150+00
160+00
PLAN
PROFILE
K+E PLATE 1. PLAN-PROFILE

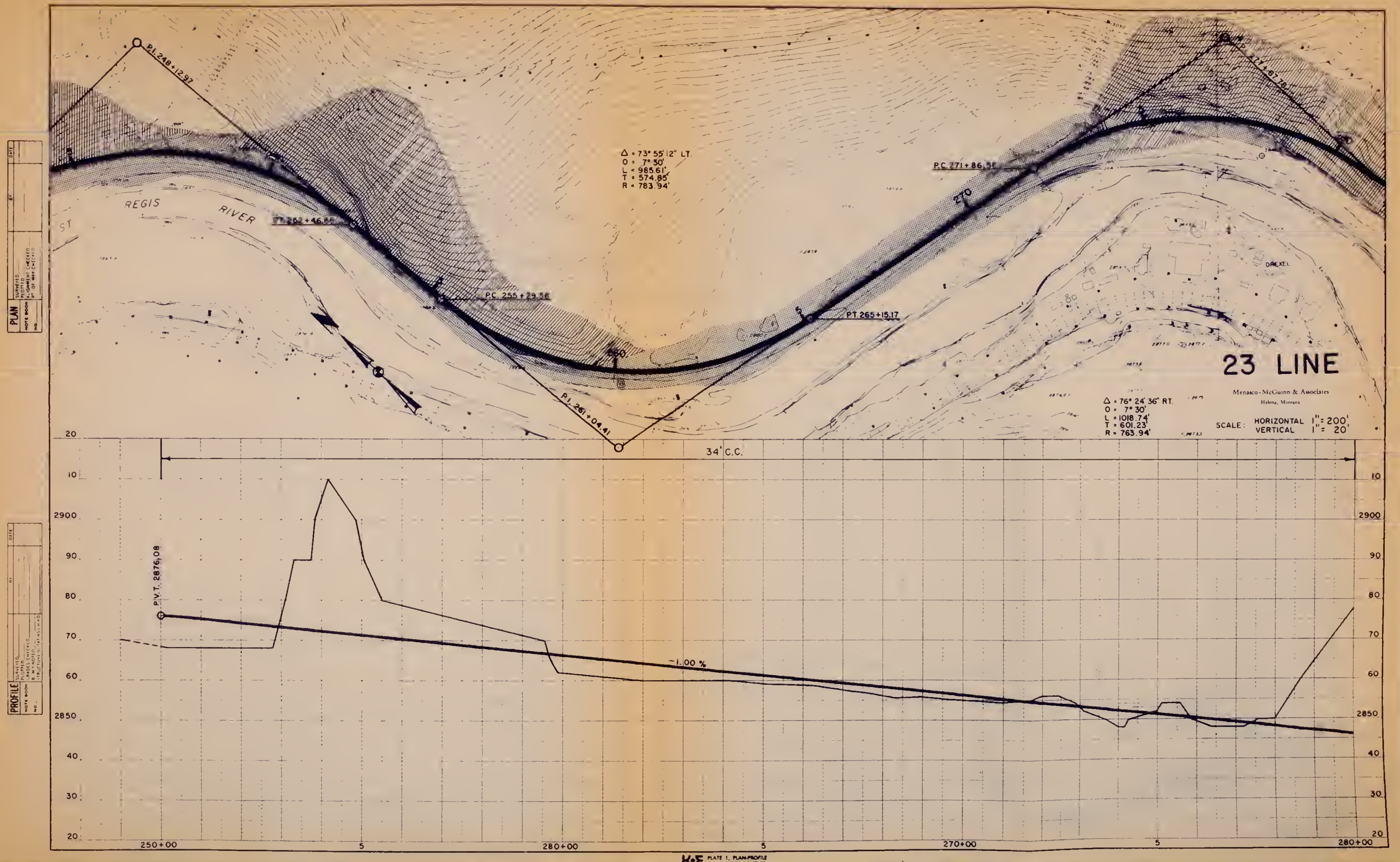


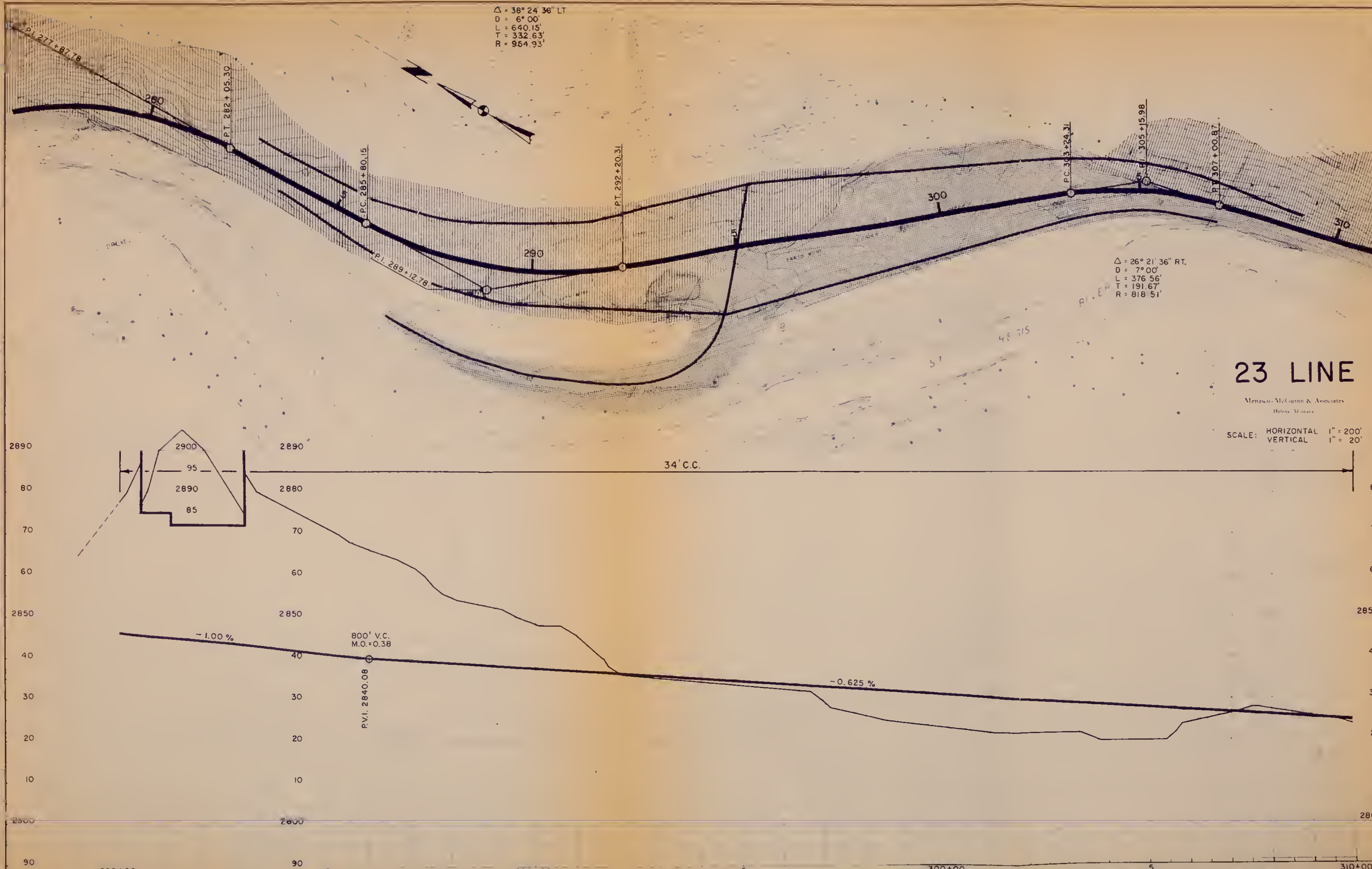
P.I. 178 + 46.67
Δ = 19° 22' 48" LT
D = 5° 30'
L = 352.29'
T = 177.84'
R = 1041.74'
P.C. 172 + 07.71
Δ = 63° 03' 00" RT.
D = 5° 30'
L = 1146.30'
T = 638.96'
R = 1041.74
RETAINING WALL
P.T. 183 + 54.01
22 LINE
P.T. 162 + 04.76
P.I. 157 + 44.11
P.C. 188 + 20.51
P.T. 191 + 72.80
P.I. 189 + 98.35
23 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 40'
34' C.C.
-0.60 %
P.V.I. 3020.00
-4.00 %
800' V.C.
M.O. = 3.40
P.T.W.
ST REGIS RIVER
℄ RY
160+00
170+00
180+00
190+00
PLAN
PROFILE
K+E PLATE 1. PLAN-PROFILE


23 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 20'
PLAN
PROFILE
ST. REGIS RIVER
CHANNEL CHANGE
RETAINING WALL
Δ = 19° 22' 48" LT.
D = 5° 30'
L = 352.29'
T = 177.84'
R = 1041.74'
Δ = 34° 32' 24" RT.
D = 7° 30'
L = 460.53'
T = 237.50'
R = 763.94'
Δ = 52° 32' 24" LT.
D = 7° 30'
L = 700.58'
T = 377.10'
R = 763.94'
P.C. 188+20.51
P.T. 191+72.80
P.C. 202+26.05
P.I. 204+63.55
P.T. 206+86.58
P.C. 210+09.76
P.I. 213+86.85
P.T. 217+10.33
P.C. 220+40.64
800' V.C.
M.O. = 1.27
P.V.I. 2956.15
-4.00 %
-1.463 %
34' C.C.
ST. REGIS RIVER
190+00
200+00
210+00
220+00
K+E

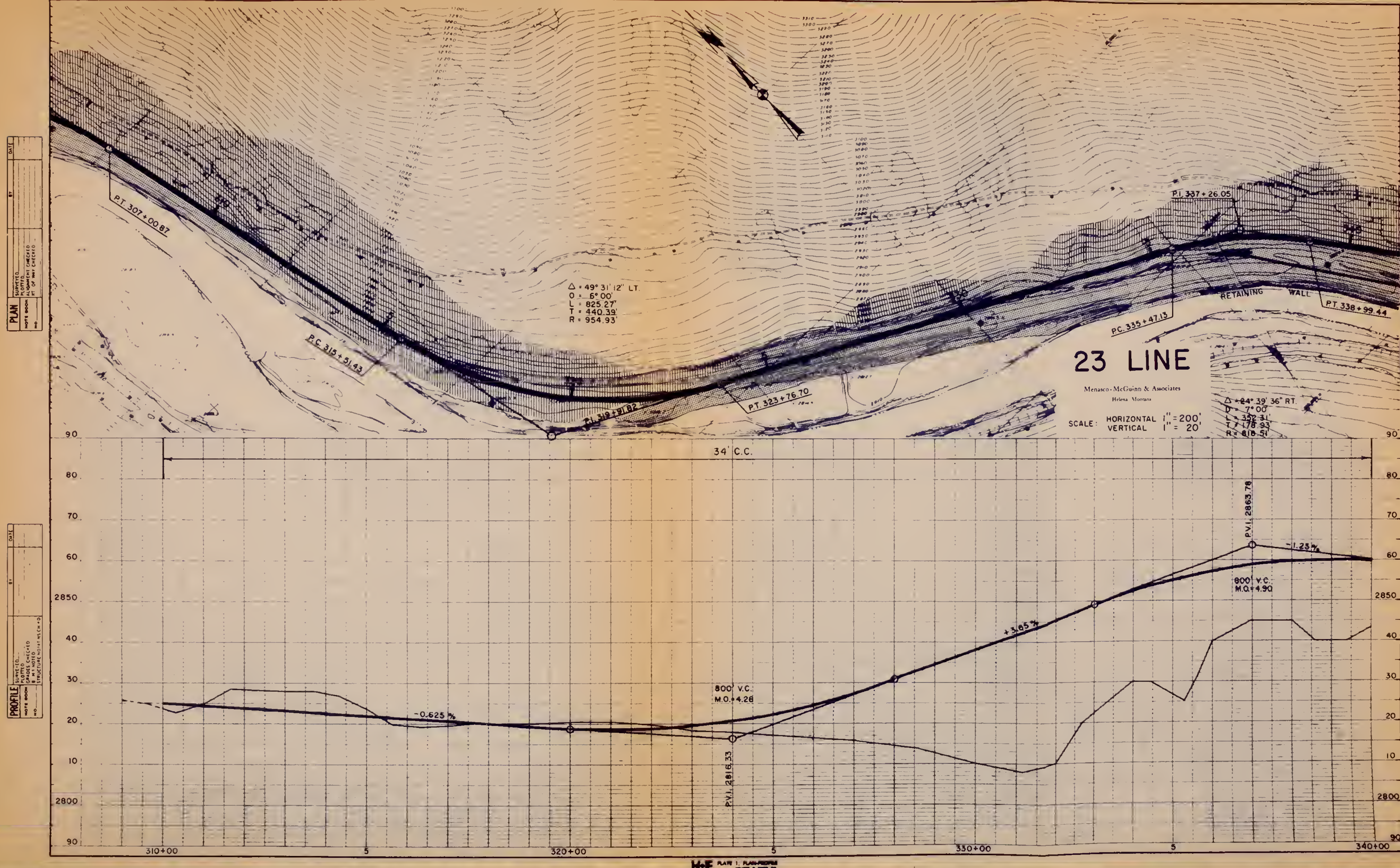


222+24.65
P.T. 217+10.33
P.C. 220+40.64
P.T. 224+02.64
P.C. 227+75.88
P.I. 232+40.65
P.T. 236+36.33
P.C. 241+08.16
P.T. 252+46.68
Δ = 25° 20' 24" RT.
D = 7° 00'
L = 362.00'
T = 184.01'
R = 818.51'
Δ = 60° 13' 48" LT.
D = 7° 00'
L = 860.45'
T = 474.78'
R = 818.51'
Δ = 85° 23' 24" RT.
D = 7° 30'
L = 1138.52'
T = 704.82'
R = 763.94'
ST. REGIS RIVER
23 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 20'
34" C.C.
-1.463 %
-1.463 %
600' V.C.
M.O. = 0.44
-1.00 %
P.V.I. 2880.00
2900
2850
220+00
230+00
240+00
250+00
PLAN
PROFILE

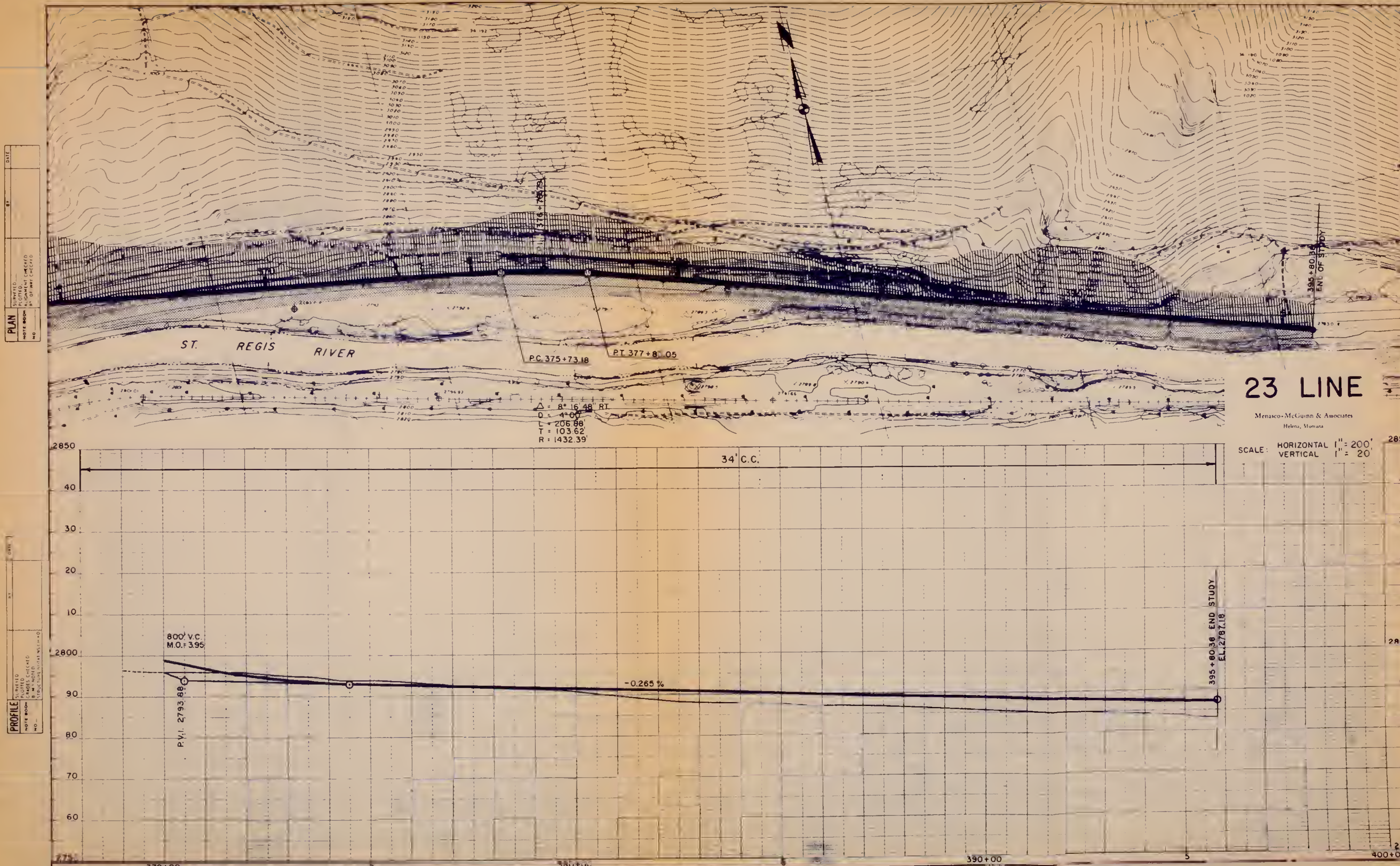

23 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 20'
ST. REGIS RIVER
DREXEL
P.I. 248+12.97
P.T. 252+46.66
P.C. 255+29.56
P.I. 261+04.41
P.T. 265+15.17
P.C. 271+86.56
Δ = 73° 55' 12" LT.
D = 7° 30'
L = 985.61'
T = 574.85'
R = 783.94'
Δ = 76° 24' 36" RT.
D = 7° 30'
L = 1018.74'
T = 601.23'
R = 763.94'
260
270
34' C.C.
P.V.T. 2876.08
-1.00 %
2900
2850
250+00
280+00
270+00
280+00
PLAN
PROFILE
K+E PLATE 1. PLAN-PROFILE
KEUFFEL & ESSER CO.



K+E PLATE 1 PLAN-PROFILE KEUFFEL & ESSER CO


23 LINE
Menasco-McGuinn & Associates
Helena Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 20'
P.T. 307+00.87
P.C. 315+51.43
P.I. 319+91.82
P.T. 323+76.70
P.C. 335+47.13
P.I. 337+26.05
P.T. 338+99.44
RETAINING WALL
Δ = 49° 31' 12" LT.
D = 6° 00'
L = 825.27'
T = 440.39'
R = 954.93'
Δ = 24° 39' 36" RT.
D = 7° 00'
L = 352.31'
T = 178.93'
R = 818.51'
34' C.C.
-0.625 %
800' V.C.
M.O. = 4.26
P.V.I. 2816.33
+3.65 %
P.V.I. 2863.78
-1.25 %
800' V.C.
M.O. = 4.90
2850
2800
310+00
320+00
330+00
340+00
PLAN
PROFILE


23 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 20'
Δ = 63° 10' 48" LT.
D = 7° 00'
L = 902.50'
T = 503.31'
R = 818.51'
Δ = 22° 14' 24" RT
D = 6° 00'
L = 370.68'
T = 187.70'
R = 954.93'
P.I. 337 + 26.06
P.T. 338 + 99.44
RETAINING WALL
P.C. 341 + 97.35
P.I. 347 + 00.66
P.T. 350 + 99.86
RETAINING WALL
P.C. 360 + 78.10
P.I. 362 + 65.80
P.T. 364 + 48.78
ST. REGIS RIVER
340
350
360
370
34' C.C.
2900
2890
2880
2870
95
85
-1.25 %
P.V.I. 2833.78
800' V.C.
M.O. ± 2.95
-4.2 %
2850
2800
340+00
350+00
360+00
370+00
PLAN
PROFILE



PLAN
ST. REGIS RIVER
P.C. 375+73.18
P.T. 377+80.05
Δ = 8° 16' 48" RT
D = 4°00'
L = 206.88'
T = 103.62'
R = 1432.39'
395+80.38 END OF STUDY
23 LINE
Menasco-McGuinn & Associates
Helena, Montana
SCALE: HORIZONTAL 1" = 200'
VERTICAL 1" = 20'
PROFILE
34' C.C.
800' V.C.
M.O. = 3.95
P.V.I. 2793.88
-0.265 %
395+80.38 END STUDY
EL. 2787.18
2850
40
30
20
10
2800
90
80
70
60
2750
370+00
5
380+00
5
390+00
5
400+00
K+E PLATE 1. PLAN-PROFILE

Part VII
"24" Line

PART VII

"24" LINE

A. INTRODUCTION

The "24" Line study was undertaken to locate an alignment that would present the least number of major cuts and provide an independent alignment of the east and westbound lanes. It becomes apparent from the study data and the "Highway Rating Index" that this approach was not feasible when compared to the other alignments studied. For this reason, the plan and profile sheets were not prepared and are not included in this report. However, the narrative and supporting data are herein presented.

B. HORIZONTAL ALIGNMENT

Beginning at the Henderson interchange area, Station 130+00, the east and westbound lanes follow a common alignment to Station 155+95 (EB). At this point, the alignment separates. The westbound lane follows the PTW around the horseshoe bend with a series of 7-degree, 30-minute curves. The eastbound lane angles off to the south of the westbound lane, crossing the river twice in a combination of 7-degree, 15-minute and 7-degree, 30-minute curves. At Station 199+07 (EB), the two lanes again assume a common alignment and continue as such for 450 feet.

Again, the alignment separates; the westbound cutting deeper into the hillside in a 7-degree, 30-minute curve and the eastbound following the PTW in a 7-degree, 30-minute curve. At the end of these curves, the alignments join again and cross the river twice between Stations 212+38 and 223+37. The alignments separate again through two 7-degree, 30-minute curves. From here the westbound lane follows the PTW quite closely. The eastbound lies south of the westbound and there is considerable conflict with the river. A 1,200 foot channel change is required to accommodate the eastbound lane between Stations 235+00 (WB) and 247+00.

A series of two more 7-degree, 30-minute curves on each alignment are now employed to keep the westbound off the hillside and the eastbound out of the river. However, another channel change is required between Stations 260+00 and 280+00 to accommodate the eastbound lane. Following this channel change, the alignment is common through a 7-degree, 30-minute curve. The two lanes separate once more through another 7-degree, 30-minute curve; then come together to a common alignment going into the Drexel interchange. From the Drexel interchange to the end of the study, the alignment is the same as the other alignments presented in this report.

Review Comments & Notes

C. VERTICAL ALIGNMENT

The first major cut on this line occurs through the nose immediately preceding the large horseshoe bend in the river. Any design on the proposed "24" Line would be undesirable from the standpoint of combined horizontal and vertical alignments.

Because of its proximity to the river going into the nose, it is necessary to keep the grade close to the PTW to prevent the fill slope from filling the river. A channel change at this point is impossible without relocating the railroad.

A maximum grade of 6 percent up the hillside and 6 percent down the other side of the nose was studied with the following results. The longest vertical curve that could be fitted in was 1,000 feet. With an algebraic difference of 12 percent, this gives a "K" factor of 83 which, according to AASHO Standards, is less than 50 m.p.h. design. It was found that a cut of 140 feet would be required with a total of nearly a million yards of excavation. This tortuous vertical alignment takes place through a 7-degree, 30-minute horizontal curve, presenting an extremely undesirable situation.

Between this cut and Drexel, there are two additional locations where a similar situation exists. In an effort to provide independent alignment through the bottom of the canyon, the vertical alignment was found to be the most restricting factor. From Drexel to the end of the study, the "24" Line employs the same vertical alignment as the "23" Line.

D. ROADWAY CROSS SECTION

Whenever possible, an independent alignment has been employed. Between Henderson and Drexel, there is approximately three miles of independent alignment. From Drexel to the end of the study, a 60-foot center-to-center common alignment is proposed. At no time does the center-to-center distance fall less than 60 feet.

E. ANNUAL COST

The "24" Line would be the most expensive of all lines studied, both in construction cost and annual cost. This is due, for the most part, to the conflict with the St. Regis River. To build the "24" Line, the cost of the retaining walls and/or cantilevered sections required to keep the highway out of the river would run in excess of one million dollars. In addition to this, the annual road user cost (operating cost) is the highest of all lines studied.

Review Comments & Notes

F. RIVER ACCESS AND CONFLICT

The "24" Line, by virtue of its location, makes roadside access to the St. Regis River impractical. Very limited access is provided near Henderson on the eastbound lane and near Drexel on the westbound lane by two rest areas. Other than this, there is no roadside access provided in conjunction with the interstate.

Again, because of its proposed location, the "24" Line causes a great deal of conflict with the river. To build this line, two major channel changes, a large amount of retaining walls or cantilevered section, and several bridges will be required.

G. MAINTENANCE

Due to the large amount of bridges and retaining walls required on this line, maintenance problems would be the greatest among all lines studied. It can be anticipated the amount of sanding and rock removal will be slightly higher than the other lines. Snow removal will be the easiest of all lines studied.

H. CONSTRUCTION METHODS

In addition to being the most costly alignment studied, the "24" Line would be the most complicated to build. This is due to the number of bridge structures required and the large amount of retaining walls necessary to confine the fill slopes at the river.

The "24" Line would present the most conflict with through-traffic during construction. In all cases, the traffic would necessarily have to be routed adjacent to or directly over the construction.

I. SCENIC EVALUATION

On the basis of our field survey, it is our conclusion that the scenic value of the "24" Line is inferior to any of the hillside alignments. The westbound lane hugs the hill so closely that there is practically no panoramic view of the canyon. The view from the eastbound lane is marred by the utility poles serving the railroad over most of its length. (See Photo No. 2, Appendix A.) The amount of cut faces is comparable to the other alignments studied.

Review Comments & Notes

J. UTILITIES

The extent to which existing utilities are effected by the "24" Line is the same as for the "21", "22" and "23" Lines with only the "20" having less conflict. The area along the PTW will not be available for relocating existing utilities or locating future utilities as would be the case with the "20", "21" or "22" Lines. Similarly, the PTW would not be available as a maintenance access road.

K. DESIGN STANDARDS

The design standards used in the "24" Line study are the same as for all other lines, except the alignment is keyed around an independent alignment of opposite lanes. See Part I-C.

L. TRAFFIC

The traffic volumes and movements are the same as for all other lines studied. See Part I-E.

M. RIGHT-OF-WAY

The right-of-way requirements are the same as for the "23" Line. See Part VI-M.

N. STRUCTURES

A total of ten major bridge structures are required on the proposed "24" Line for a total of 2,650 linear feet, or 134,200 square feet of deck area. The structures crossing the river are not nearly as high as those on the "21" and "22" Lines. The "24" Line will require at least 6,650 linear feet of retaining wall with an average height of 13 feet.

(1) Henderson Interchange

Refer to Part II - Henderson Interchange.

(2) Station 391+50 to Station 395+50 (Eastbound)

The proposed structure at this location will be 38 feet wide between curbs and approximately 400 feet long, with a total deck area of 15,200 square feet. This bridge will be a comparatively low structure consisting of four spans. Since the interior span crossing the river is in the order of magnitude of 135 feet, a composite poured concrete deck with steel plate girder stringers is proposed for this structure. Other general

Review Comments & Notes

construction characteristics of this bridge are similar to the structure between Stations 166+54 to 172+26, Part IV - "21" Line.

(3) Station 400+50 to Station 405+50 (Eastbound)

This structure will be similar to the structure above, between Stations 391 + 50 and 395 + 50 with general construction characteristics similar to that of the structure between Stations 166+54 and 172+26 in Part IV - "21" Line. Due to the width of the river at this point and because of the skew angle of this bridge, a pier at the center of the river may be indicated here, which would require two interior spans of approximately 130 feet each.

The width of deck between curbs will be 38 feet and the total length of the bridge approximately 500 feet. The total deck area will be approximately 19,000 square feet.

(4) Station 432+30 to Station 436+50

With exception of over-all length, which is 420 feet, this structure will be, in all other respects, similar to the structure between Stations 196 + 75 and 200 + 05 in Part VI - "23" Line. The total area of bridge deck will be 32,760 square feet.

(5) Station 440+50 to Station 445+50

This structure in all respects, with the exception of its over-all length and the location of piers, will be similar to the structure between Stations 202+90 and 207+05 in Part VI- "23" Line. The over-all length of this structure is approximately 500 feet and being 78 feet wide between curbs has a total deck area of 39,000 square feet.

(6) Drexel Interchange (Crossroad)

Refer to Part VI - "23" Line.

(7) River Crossing to Drexel

This will be a relatively low structure and would be similar in general construction characteristics to the Drexel interchange (crossroad) structure, Part VI - "23" Line. The approximate over-all length of this bridge will be 300 feet which, with a 32 foot width between curbs, will give a deck area of 9,600 square feet.

O. GEOLOGY

The geological factors effecting the "24" Line are the same as for all lines and are discussed in Part I-H.

Review Comments & Notes

P. DRAINAGE

The drainage problems and recommendations are the same as for the "23" Line and are discussed in Part VI-P.

Q. HIGHWAY RATING INDEX

An examination of each individual comparison shows why this line did not rate favorably with other alignments. All ratings and the backup data for the "24" Line are shown on the following charts.

Review Comments & Notes

HORIZONTAL ALIGNMENT - "24" LINE

Comparison Items	Amount	Points
Total Length of Comparison:		
Feet.	31,594.67'	
Miles	5.984	2
Total Number of Curves	20	
Curve Frequency Per Mile	3.34	4
Maximum Degree of Curvature.	7.50°	6
Average Degree of Curvature.	6.32°	2
Average Length of Curve.	887.70'	2
Average Deflection Per Curve	54.50°	2
Total Deflection Over Comparison	1,089.97°	2
Average Deflection Per Mile.	182.15°	2
Total Feet Curvilinear Roadway	17,754.06'	2
Percent of Curvilinear Roadway	56.2%	2
Average Tangent Between Curves	601.62'	2
Total Number of Structures	10	4
TOTAL POINTS.		32

PART VII - Table 1

Review Comments & Notes

HORIZONTAL ALIGNMENT DATA - "24" LINE

Curve Number	Deflection Angle	Degree of Curve	Length	Distance P.C. to P.T.
1*	62.18°	2.75°	2,260.98'	
				618.44'
2	37.18°	3.25°	1,143.91'	
				1,087.16'
3	98.93°	7.50°	893.48'	
				448.54'
4	101.01°	7.50°	1,346.77'	
				951.67'
5	59.20°	7.00°	845.69'	
				447.00'
6	66.32°	7.50°	884.25'	
				482.21'
7	43.18°	7.00°	616.81'	
				350.50'
8	50.34°	7.50°	671.24'	
				440.02'
9	26.44°	5.00°	528.89'	
				258.77'
10	61.65°	7.50°	822.03'	
				574.18'
11	76.43°	7.50°	1,019.03'	
				383.46'
12	70.92°	7.50°	945.58'	
				490.23'
13	81.68°	7.50°	1,089.05'	
				504.68'
14	50.45°	6.00°	840.86'	
				629.30'
15	41.14°	5.00°	822.83'	
				849.68'
16	49.52°	6.00°	825.27'	
				1,170.44'
17	24.66°	7.00°	352.31'	
				297.91'
18	63.18°	7.00°	902.50'	
				1,011.66'
19	22.26°	6.00°	370.68'	
				1,124.67'
20	8.25°	4.00°	206.20'	
Total	1,089.97°	126.40°	17,754.06'	11,430.78'
Average	54.50°	6.32°	887.70'	601.62'

Percent of Curvilinear Roadway = $\frac{17,754.06}{31,594.67} = 56.2\%$

Average Deflection Per Mile = $\frac{1,089.97}{5.984} = 182.15°$

* Henderson Interchange Area.

Review Comments & Notes

VERTICAL ALIGNMENT - "24" LINE

Comparison Items	Amount	Points
Total Length of Comparison:		
Feet.	31,594.67'	
Miles	5.984	2
Total Number of Vertical Curves.	13	
Curve Frequency Per Mile	2.17	10
Average Length of Vertical Cruve	800.00'	
Average Algebraic Difference	3.029%	
K Factor (1)	264.11	9
Maximum Grade in Comparison.	6.000%	2
Average Grade in Comparison.	2.182%	2
Percentage of Roadway with:		
5% Grade or More.	11.1%	2
3% - 5% Grade	16.0%	4
2% - 3% Grade	8.6%	9
Less than 2% Grade.	64.3%	8
TOTAL POINTS.		48

(1) K = Average length of vertical curve divided by average algebraic difference.

NOTE: Vertical alignment would be comparable to "23" Line.

Review Comments & Notes

ROADWAY CROSS SECTION - "24" LINE

Comparison Items	Template B Amount	Template B Points
34' Center-Center, Miles	0.000	
60' Center-Center, Miles	5.984	
34' Center-Center	0.000%	16
60' Center-Center	100.00%	16
TOTAL POINTS		32

Review Comments & Notes

ROADWAY CROSS SECTION DATA - "24" LINE

	34' Center-Center (Miles)	60' Center-Center (Miles)
Template B: (Only)		
100+00 to 415+95.38	5.984	0.000
Total	5.984	0.000
Per Cent	100.00%	0.000%

Review Comments & Notes

COST ESTIMATE - "24" LINE

	CAPITAL RECOVERY FACTOR		TEMPLATE B Minimum 60' Ctr-Ctr	
	Years	Interest	Const. Cost	Annual Cost
Guard Rail	20	0.0872	$ 222,972	$ 19,440
Base, Surfacing & Pavement	20	0.0872	1,066,331	92,968
Grading, Earthwork & Channel Change	40	0.0665	1,191,580	79,194
Drainage	40	0.0665	222,077	14,760
Retaining Walls.	50	0.0634	109,500	6,947
Major Structures	50	0.0634	1,706,080	108,241
Cantilever Section . . .	50	0.0634	1,460,000	92,629
Utilities.	50	0.0634	80,500	5,107
Rest Area.	20	0.0872	28,685	2,500
Traffic Control.	20	0.0872	48,892	4,262
TOTAL CONSTRUCTION COST.			$6,136,617	
Sub-Total Annual Cost				$ 426,048
Percentage of Construction Cost Differential			156.0%	
Maintenance:				
Interstate 4-Lane @ $3,000/Mile . . .				17,951
Crossroad & Interchange Ramps @ $1,500/Mile				4,689
Operating Cost				1,202,076
TOTAL ANNUAL COST.				$1,650,764

PART VII - Table 6

Review Comments & Notes

RIVER ACCESS & CONFLICT - "24" LINE

Comparison Items	Amount	Points
Total River Access, Miles.	1.287	2
Percent of Present Access Retained	22%	2
Present Access Road (PTW) Relocated, Miles[1]	0.682	2
Minor River Conflict, Feet[2].	2,200'	2
Major River Conflict, Feet[3].	3,650'	2
River Improvement[4]	None	5
River Access Continuous Between Henderson and Drexel.	No	3
TOTAL POINTS.		18

(1) The access to the river is provided from two rest areas.

(2) Encroachment on present river bed not requiring channel change or retaining wall.

(3) Encroachment on present river bed requiring undesirable channel change or retaining wall.

(4) Desirable channel change, flood plain improvement, etc.

Review Comments & Notes

RIVER ACCESS & CONFLICT DATA

"24" LINE, TEMPLATE B

Items	1	(b) 2	3	4	5
	Amt. River Access	Percent Access Main-tained	Total Constr. Items 1 & 2	Amt. Minor Conflict	Amt. Major Conflict
Henderson Interchange	2,696'	8.78%			
West Rest Area (Eastbound Only)	2,300'	7.49%	1,800'[(a)]		
East Rest Area (Westbound Only)	1,800'	5.86%	1,800'[(a)]		
Channel Changes					2,650'
Retaining Wall					1,000'
Fill Slope Encroachment				2,200'	
Total Feet	6,796'	22.13%	3,600'	2,200'	3,650'
Total Miles	1.287	22.13%	0.682		

(a) Approximate ramp length to provide access at rest areas.

(b) Present access is approximately 5.81 miles.

Review Comments & Notes

MAINTENANCE - "24" LINE

Comparison Items	Template B Amount	Template B Points
Snow Removal:		
Percent of Roadway with Depressed Median.	100.00%	16
Rock Removal:		
Linear Feet of Cut Ditch.	22,161'	2
Structure Maintenance:		
Linear Feet of Structures	9,300'	2
Sanding:		
Linear Feet of Problem Roadway. . . .	10,044'	2
TOTAL POINTS.		22

Review Comments & Notes

MAINTENANCE DATA - "24" LINE

SNOW REMOVAL

$$\frac{\text{Total Miles of Depressed Median}}{\text{Total Length of "24" Line}} = \frac{5.984}{5.984} = 100.00\%$$

ROCK REMOVAL

Location	Cut Ditch (Lin.Ft.)
190+00 to 111+30	230'
134+50 to 146+50	1,200'
150+00 to 163+30, Rt & Lt	1,330'
172+10 to 177+50, Rt & Lt	1,080'
190+50 to 195+50	500'
207+00 to 214+50	750'
225+00 to 231+75	675'
238+00 to 245+00	700'
250+00 to 259+50	950'
259+50 to 274+00, Rt & Lt	4,200'
305+00 to 310+00	500'
310+00 to 322+50	2,500'
335+00 to 342+75	725'
342+75 to 350+00	725'
355+00 to 415+96	6,096'
TOTAL	22,161'

STRUCTURE MAINTENANCE

Total Linear Feet of Major Structures	2,650'
Total Linear Feet of Retaining Walls	6,650'
TOTAL Linear Feet of Structure Maintenance	9,300'

SANDING

Total Linear Feet of Roadway with 3% grade or more	7,394.16'
Total Linear Feet of Bridge Deck	2,650.00'
TOTAL Linear Feet of Problem Roadway	10,044.16'

Review Comments & Notes

CONSTRUCTION METHODS - "24" LINE

Comparison Items	Amount	Points
Traffic Control.		2
Earthwork Balance.		3
Simplicity		3
TOTAL POINTS		8

TRAFFIC CONTROL

(Miles)		
Length of Detour Comprised of PTW.	0.905	2
Length of Detour to be Constructed	6.500	2
Length of Detour Separated from Construction	2.131	2
Length of Detour on or Adjacent to Construction	4.369	2
TOTAL POINTS		8

EARTHWORK BALANCE

Does the Total Earthwork Balance?.	No	3
Total Number of Balance Points	4	3
Average Distance Between Balance Points (Miles)	1.196	2
TOTAL POINTS		8

SIMPLICITY

Total Linear Feet Major Structures	2,650'	2
Total Linear Feet Retaining Wall	6,650'	2
TOTAL POINTS		4

Review Comments & Notes

CONSTRUCTION METHODS DATA

SIMPLICITY - "24" LINE

MAJOR STRUCTURE DATA

Location	Length	Width	Deck Area (Sq.Ft.)
Henderson Interchange, Eastbound	140'	38'	5,320
Henderson Interchange, Westbound	140'	38'	5,320
391+50 to 395+50, Eastbound	400'	38'	15,200
400+50 to 405+50, Eastbound	500'	38'	19,000
432+30 to 434+40	420'	78'	32,760
440+50 to 445+50	500'	78'	39,000
Drexel Interchange, Crossroad	250'	32'	8,000
River Crossing to Drexel	300'	32'	9,600
TOTAL	2,650'		134,200

RETAINING WALL DATA

Location	Linear Feet
397+00 to 401+50	450'
410+50 to 414+00	350'
510+00 to 521+00	1,100'
540+00 to 556+00	1,600'
570+50 to 580+50	1,000'
587+50 to 606+00	1,850'
TOTAL	6,650'

PART VII - Table 12

Review Comments & Notes

SCENIC EVALUATION - "24" LINE

Comparison Items	Template B Amount	Template B Points
Panorama	*	2
Total Area Cut Faces (Square Yards). . . .	330,943	4
Number of Areas Where View is Enhanced Over a High Fill.	0	3
TOTAL POINTS.		9

* Value judgment based upon field survey; see Scenic "Basis of Evaluation".

Review Comments & Notes

SCENIC EVALUATION DATA - "24" LINE

Location	Cut Face (Sq.Yd.)
190+00 to 111+30	3,644
134+50 to 146+50	22,800
150+00 to 163+30, Rt & Lt.	20,933
172+10 to 177+50, Rt & Lt.	12,489
190+50 to 195+50	3,022
207+00 to 214+50	11,733
225+00 to 231+75	11,644
238+00 to 245+00	15,111
250+00 to 259+50	25,333
259+50 to 274+00, Rt & Lt.	60,089
305+00 to 310+00	10,667
310+00 to 322+50	27,600
326+50 to 330+80	2,222
332+00 to 335+50	2,667
335+00 to 342+75	13,111
342+75 to 350+00	16,400
355+00 to 415+96	71,478
TOTAL	330,943

Review Comments & Notes

UTILITIES - "24" LINE

Comparison Items	Points
Versatility of Location*	3

* For explanation of how points were assigned, see "Basis of Evaluation".

Review Comments & Notes

Part VIII
Summary &
Recommendations

P A R T V I I I

SUMMARY AND RECOMMENDATIONS

A. INTRODUCTION

This section of the report presents the nine comparisons used to develop the "Highway Rating Index". Each comparison is presented in an itemized table preceded by a brief explanation of how the comparison was made and a summary discussion of why the alignments scored as they did.

An examination of these comparisons will show that a considerable amount of data was accumulated, compared, and scored in order to select the most feasible alignment. The final recommendation presented in this report is based upon numerous related considerations, rather than the one or two major items.

Review Comments & Notes

HORIZONTAL ALIGNMENT COMPARISON

A. BASIS OF EVALUATION

Any horizontal alignment through the St. Regis canyon is dictated by the terrain and must necessarily be curvilinear. The purpose of this evaluation is to compare the severity of curvature between the various alignments considered. This has been accomplished by comparing the various elements of a horizontal curve, the length of tangents between curves, and the factors contributing to the alignment as a whole.

B. EVALUATION SUMMARY

Perhaps the most significant fact brought out by this evaluation is that the differences between any of the alignments studied are exceedingly small.

The "21" Line scored the highest number of points in this evaluation. One could expect this because the "21" Line was conceived to ease the horizontal alignment across the large horseshoe bend in the river near the beginning of the project. To realize this advantage, however, the "21" Line requires two rather costly bridge structures at this point. Aside from the horseshoe bend area, the "20", "21" and "22" Lines have basically the same horizontal alignment.

The "23" Line scored well in this evaluation, taking third place. Our original thought was that a water level location would be too confined for good horizontal alignment. The evaluation shows this is not necessarily true.

On the other hand, the "24" Line is a water level location, yet scored last in this evaluation. This is due to the fact that in order to provide an independent alignment, which was the reason for studying the "24" Line, it was necessary to press the horizontal alignment to the maximum allowable standards throughout a major portion of the canyon.

Review Comments & Notes

HORIZONTAL ALIGNMENT COMPARISON										
	"20"		"21"		"22"		"23"		"24"	
COMPARISON ITEMS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS
Total Length of Comparison:										
Feet....................	30,644.55'		29,100.09'		29,344.69'		29,580.39'		31,594.67'	
Miles...................	5.804	4	5.511	10	5.558	8	5.602	6	5.984	2
Total Number of Curves.......	19		16		18		19		20	
Curve Frequency Per Mile.....	3.27	6	2.90	10	3.24	8	3.39	2	3.34	4
Maximum Degree of Curvature..	7.50°	6	7.50°	6	7.50°	6	7.50°	6	7.50°	6
Average Degree of Curvature..	6.18°	5	5.81°	10	5.88°	8	6.17°	5	6.32°	2
Average Length of Curve......	848.52'	4	773.72'	8	767.08'	10	778.77'	6	887.70'	2
Average Deflection Per Curve.	50.80°	4	42.02°	8	41.92°	10	45.08°	6	54.50°	2
Total Deflection Over Comparison..............	965.27°	4	672.39°	10	754.60°	8	856.49°	6	1,089.97°	2
Average Deflection Per Mile..	166.31°	4	122.01°	10	135.77°	8	152.89°	6	182.15°	2
Total Feet Curvilinear Roadway.................	16,121.90'	4	12,379.47'	10	13,807.37'	8	14,796.70'	6	17,754.06'	2
Percent of Curvilinear Roadway.................	52.6%	4	42.5%	10	47.0%	8	50.0%	6	56.2%	2
Average Tangent Between Curves..................	679.87'	4	958.84'	10	779.61'	8	694.70'	6	601.62'	2
Total Number of Structures...	4	10	8	7	8	7	12	2	10	4
Total Points...........		59		109		97		63		32
HIGHWAY RATING INDEX.........	4		1		2		3		5	

PART VIII - Table 1

VERTICAL ALIGNMENT COMPARISON

A. BASIS OF EVALUATION

This evaluation has been made in the same manner as the horizontal comparison; that is, the elements of vertical alignment design have been averaged throughout each alignment, and compared against each other.

B. EVALUATION SUMMARY

The "23" Line scored the highest in this evaluation. This was to be expected, since the prime purpose in studying the "23" Line was to locate a water level alignment. It was possible to follow the PTW grade over much of the canyon, but in doing so, a serious earthwork problem is created. The vertical alignment studied for the "23" Line leaves little or no room for adjustment to alleviate this problem.

The "22" and "21" Lines placed second and third respectively; the major difference between the two being the amount of roadway having a 3 percent grade or greater. Both are good, being neither strenuous or inconsistent throughout the project.

The "24" Line experiences several severe vertical conditions in the first two miles, calling for maximum design features. After that, the grades are very similar to the "23" Line. Due to the superior vertical alignment in the middle portion of the project, the "24" Line averaged out in fourth position.

The "20" Line finished last in this evaluation. This is due to the fact that additional sacrifices were made in vertical alignment to reduce and balance earthwork; this being a major objective of the "20" Line.

Review Comments & Notes

VERTICAL ALIGNMENT COMPARISON										
	"20"		"21"		"22"		"23"		"24" (2)	
COMPARISON ITEMS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS
Total Length of Comparison:										
Feet....................	30,644.55'		29,100.09'		29,344.69'		29,580.39'		31,594.67'	
Miles..................	5.804	4	5.511	10	5.558	8	5.602	6	5.984	2
Total Number of Vertical Curves..................	13		12		15		13		13	
Curve Frequency Per Mile.....	2.24	6	2.18	8	2.70	2	2.32	4	2.17	10
Average Length of Vertical Curve..................	876.90'		850.00'		733.33'		800.00'		800.00'	
Average Algebraic Difference.	4.020%		3.663%		3.009%		3.029%		3.029%	
"K" Factor(1)................	218.13	2	232.05	4	243.71	6	264.11	9	264.11	9
Maximum Grade in Comparison..	5.194%	5	5.000%	5	4.660%	9	4.660%	9	6.000%	2
Average Grade in Comparison..	2.178%	4	2.123%	6	1.867%	10	2.049%	8	2.182%	2
Percentage of Roadway with:										
5% Grade or More........	9.5%	4	8.6%	6	0.0%	9	0.0%	9	11.1%	2
3% - 5% Grade...........	12.4%	10	13.1%	8	15.3%	6	16.4%	2	16.0%	4
2% - 3% Grade...........	39.6%	2	31.1%	6	34.2%	4	8.6%	9	8.6%	9
Less than 2% Grade......	38.5%	2	47.3%	4	50.4%	6	75.0%	10	64.3%	8
Total Points...........		39		57		60		6[illegible]		48
HIGHWAY RATING INDEX.........	5		3		2		1		4	

(1) "K" = Average length of vertical curve divided by average algebraic difference.
(2) Vertical alignment would be comparable to "23" Line.

PART VIII - Table 2

ROADWAY CROSS SECTION COMPARISON

A. BASIS OF EVALUATION

This evaluation was based upon the conclusion that a depressed median between lanes is superior to a barrier guard rail median.

Two studies were conducted over the "20", "21" and "22" Lines. The first, "Template A", studies the alignment using a 34-foot center - to - center cross section with barrier guard rail median exclusively from the Henderson interchange to the end of the study. The second, "Template B", studies the same alignments using a combination of the 34-foot section and a 60-foot center-to-center depressed median cross section.

B. EVALUATION SUMMARY

The "24" Line scored the highest because its design is based upon an independent alignment of opposing lanes; consequently, it has no barrier guard rail section.

Among the other alignments studied, the Template B lines will obviously score higher because the Template A lines are all barrier median beyond the Henderson interchange.

The "20" Line, Template B, scored second to the "24" Line, because it provided the greatest percentage of depressed median section over its length.

The "23" Line, by virtue of its intended design, makes any depressed median section impractical from the standpoint of economics alone. As a result, the "23" Line scored poorly in this evaluation.

Review Comments & Notes

ROADWAY CROSS SECTION COMPARISON

	"20"				"21"				"22"				"23"		"24"	
	TEMPLATE A		TEMPLATE B		TEMPLATE A		TEMPLATE B		TEMPLATE A		TEMPLATE B		TEMPLATE A		TEMPLATE B	
COMPARISON ITEMS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS
34' Center-Center, Miles............	5.277		2.273		4.984		3.641		5.031		3.689		5.075		0.000	
60' Center-Center, Miles............	0.527		3.538		0.527		1.876		0.527		1.876		0.527		5.984	
34' Center-Center......	90.92%	2	39.12%	14	90.44%	8	66.00%	12	90.52%	6	66.29%	10	90.59%	4	0.000%	16
60' Center-Center......	9.08%	2	60.88%	14	9.56%	8	34.00%	12	9.48%	6	33.71%	10	9.41%	4	100.00%	16
Total Points......		4		28		16		24		12		20		8		32
HIGHWAY RATING INDEX...	8		2		5		3		6		4		7		1	

PART VIII - Table 3

TOTAL ESTIMATED COST COMPARISON

A. BASIS OF EVALUATION

Economics has always been a major consideration in highway location and design. Not too long ago, it was practically the only determining factor; but in recent years, it has come to share its importance with other significant considerations. Such is the case in this route location study.

This particular comparison is based upon one item only, the estimated total annual cost, and has been rated accordingly.

B. EVALUATION SUMMARY

While this item was rated on the total annual cost only, it is interesting to note how the different alignments compare in the individual cost items.

Total construction costs ranged from 3.94 million dollars on the "20" Line, Template A, to 6.14 million dollars on the "24" Line.

The "20" Line, Template B, scored the highest number of total points on the Highway Rating Index; yet would be the second least costly to construct at 4.42 million dollars. The savings realized by eliminating the two major structures over the horseshoe bend area are 1.76 million dollars, while the increased grading costs are only 0.165 million dollars, for a net savings of 1.595 million dollars.

To use the "20" Line as an example to show how much it would cost to provide the depressed median cross section: the additional grading, surfacing and earthwork costs would be 0.57 million dollars; subtracting the cost of the barrier guard rail (0.123 million dollars), the net additional cost to provide the depressed median cross section is 0.446 million dollars.

While the "21" and "22" Lines succeeded in lowering the operating costs over the "20" Line by 0.058 million dollars and 0.051 million dollars annually, the savings were not sufficient to overcome the lower total construction cost of the "20" Line.

The total construction costs on the "23" Line (6.16 million dollars) are higher than any of the hillside alignments. This is due mainly to the additional structures required on the "23" Line. Again, the "23" Line, as studied in this report, does not provide any depressed median beyond the Henderson interchange. The operating cost on the "23" Line (1.126 million dollars an-

Review Comments & Notes

nually) is slightly less than the "20" Line, but slightly higher than the "21" or "22" Lines.

The "24" Line would be the most costly alignment to construct at 6.137 million dollars, or 56 percent higher than the least costly alignment. The higher construction costs are due to the structures necessary to maintain the river. The operating costs are also the highest of all alignments studied.

Review Comments & Notes

TOTAL COST ESTIMATE COMPARISON

STUDY LINE NUMBER			STUDY LINE "20"				STUDY LINE "21"				STUDY LINE "22"				STUDY LINE "23"		STUDY LINE "24"	
TOTAL PROJECT LENGTH			30,679.2 FEET = 5.81 MILES				29,134.9 FEET = 5.52 MILES				29,379.2 FEET = 5.56 MILES				29,615.2 FEET = 5.61 MILES		30,504.7 FEET = 5.98 MILES	
SURFACING + STRUCTURES (LINEAR FEET)			30,539.2 + 140.0				27,842.9 + 1,292.0				28,103.2 + 1,276.0				27,573.2 + 2,042.0		30,504.7 + 1,090.0	
ROADWAY CLASSIFICATION			TEMPLATE "A" 34' CTR.-CTR. ONLY		TEMPLATE "B" 34' CTR.-CTR. & 60' CTR.-CTR.		TEMPLATE "A" 34' CTR.-CTR. ONLY		TEMPLATE "B" 34' CTR.-CTR. & 60' CTR.-CTR.		TEMPLATE "A" 34' CTR.-CTR. ONLY		TEMPLATE "B" 34' CTR.-CTR. & 60' CTR.-CTR.		TEMPLATE "A" 34' CTR.-CTR. ONLY		TEMPLATE "B" MINIMUM 60' CTR.-CTR.	
	CAPITAL RECOVERY FACTOR YEARS	CAPITAL RECOVERY FACTOR INTEREST	CONSTR. COST	ANNUAL COST	CONSTR. COST	ANNUAL COST	CONSTR. COST	ANNUAL COST	CONSTR. COST	ANNUAL COST	CONSTR. COST	ANNUAL COST	CONSTR. COST	ANNUAL COST	CONSTR. COST	ANNUAL COST	CONSTR. COST	ANNUAL COST
GUARD RAIL	20	0.0872	$ 339,720	$ 29,618	$ 216,511	$ 18,876	$ 310,434	$ 27,065	$ 257,666	$ 22,465	$ 317,929	$ 27,718	$ 274,822	$ 23,960	$ 296,338	$ 25,836	$ 222,972	$ 19,440
BASE, SURFACING & PAVEMENT	20	0.0872	1,097,361	95,673	1,106,881	96,503	1,005,737	87,685	1,013,504	88,362	1,014,584	88,456	1,022,424	89,140	996,571	86,886	1,066,331	92,968
GRADING, EARTHWORK & CHANNEL CHANGE	40	0.0665	1,924,201	127,885	2,484,289	165,110	1,969,927	130,924	2,257,330	150,026	1,656,173	110,072	1,965,039	130,600	1,844,210	122,569	1,191,580	79,194
DRAINAGE	40	0.0665	181,250	12,046	219,878	13,284	166,370	11,057	193,824	12,882	166,370	11,057	193,824	12,882	155,190	10,314	222,077	14,760
RETAINING WALLS	(		84,600	5,367	84,600	5,367	84,600	5,367	84,600	5,367	89,400	5,672	89,400	5,672	108,000	6,852	109,500	6,947
MAJOR STRUCTURES	(50	0.0634	127,680	8,101	127,680	8,101	1,924,800	122,118	1,878,720	119,194	1,899,840	120,534	1,854,400	117,651	2,604,336	165,230	1,706,080	108,241
CANTILEVER SECTION	(		-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1,460,000	92,629
UTILITIES	50	0.0634	104,500	6,630	104,500	6,630	79,500	5,044	79,500	5,044	77,500	4,917	77,500	4,917	79,500	5,044	80,500	5,107
REST AREA	20	0.0872	28,685	2,500	28,685	2,500	28,685	2,500	28,685	2,500	28,685	2,500	28,685	2,500	28,685	2,500	28,685	2,500
TRAFFIC CONTROL	20	0.0872	48,824	4,256	48,824	4,256	48,708	4,246	48,708	4,246	48,724	4,247	48,724	4,247	48,744	4,249	48,892	4,262
TOTAL CONSTRUCTION COST			$ 3,936,821		$ 4,421,848		$ 5,618,761		$ 5,842,537		$ 5,299,205		$ 5,554,818		$ 6,161,574		$ 6,136,617	
SUB-TOTAL ANNUAL COST				$ 292,076		$ 320,627		$ 392,006		$ 410,086		$ 375,173		$ 391,569		$ 429,480		$ 426,048
PERCENTAGE OF CONSTRUCTION COST DIFFERENTIAL			100%		112.5%		142.5%		148.5%		134.5%		141.0%		156.5%		156.0%	
MAINTENANCE:																		
INTERSTATE 4-LANE AT $3,000/MILE				17,430		17,430		16,554		16,554		16,692		16,692		16,884		17,951
CROSS-ROAD & INTERCHANGE RAMPS AT $1,500/MILE				4,689		4,689		4,689		4,689		4,689		4,689		4,689		4,689
OPERATING COST				1,165,704		1,165,704		1,107,873		1,107,873		1,115,010		1,115,010		1,126,218		1,202,076
TOTAL ANNUAL COST				$ 1,479,899		$ 1,508,450		$ 1,521,122		$ 1,539,202		$ 1,511,564		$ 1,527,960		$ 1,577,271		$ 1,650,764
HIGHWAY RATING INDEX				1		2		4		6		3		5		7		[illegible]

RIVER ACCESS AND CONFLICT COMPARISON

A. BASIS OF EVALUATION

The results of this evaluation should be given serious consideration in the location of Interstate I - 90 through the St. Regis canyon.

For this comparison, "river access" is defined as the actual number of miles of riverside access provided by a road other than the interstate; or in other words, the amount of access where a motorist can safely stop along the river. The interstate along the river without such access presents an undesirable situation inasmuch as motorists will inevitably want to park along the interstate.

The hillside alignments, "20", "21" and "22", provide the opportunity to maintain most of the present traveled way from Henderson to Drexel. Inexpensive relocation of the remaining portion of the PTW will provide the public with complete access to the river between these two points. The interchanges at Henderson and Drexel provide access to this river road at either end. It is felt that any of the alignments presented in this report make it impractical to consider providing access to the river beyond the Drexel interchange.

For this comparison, "river conflict" is defined as that portion of the St. Regis River that is disturbed by the construction of Interstate I-90. "Minor conflict" is measured in feet of encroachment on the river by fill slopes not requiring channel change or retaining walls. "Major conflict" is measured in feet of encroachment on the river requiring channel change or retaining walls.

With the exception of the "23" Line, the river conflict has been measured based upon the 60 - foot center - to - center section only, considering any conflict to be proportionately less with a 34 - foot center - to - center section for any alignment. The "23" Line has been measured based upon the 34-foot center-to-center section only.

The evaluation is comprised of the following items:

(1) Total miles of access to the St. Regis River.
(2) Percent of present access maintained.
(3) Miles of construction necessary to provide Items 1 and 2.
(4) Linear feet of major and minor conflict with the river.
(5) Amount of improvement to present river channel.
(6) Whether or not access to river is continuous between Henderson and Drexel.

Review Comments & Notes

B. EVALUATION SUMMARY

The hillside alignments, "20", "21" and "22", all allow an equal amount of continuous river access road between Henderson and Drexel. Among these three, all retain an equal amount of the PTW. Due to certain fill slopes, the additional construction required to provide the river access road would be slightly more on the "20" Line than on the "22" Line, with the "21" Line requiring less than either one.

The "23" Line would allow about half as much river access than the three hillside alignments with access from the Henderson interchange only. The amount of additional construction required in conjunction with the "23" Line is practically negligible.

Because of its intended design, the location for the "24" Line prohibits any roadside access to the river. Limited access to the river would be provided for eastbound traffic by a rest area near Henderson, and for westbound traffic by a rest area near Drexel. However, it would not be as beneficial to the public as the continuous roadside access provided by the other alignments.

The "20" Line had the highest composite score in this comparison because it would create the least amount of conflict with the river. The only areas of conflict with the river on the "20" Line occur beyond Drexel and are common to all the alignments studied.

The "23" Line would create more river conflict than any of the hillside alignments because of its location. Two additional river crossings requiring major bridge structures are necessary on the "23" Line. However, one advantage is gained at this point in that the river would be lengthened by eliminating a channel change made when the present U.S. 10 was constructed, thus returning the river to its natural location.

Again, by virtue of its location, the "24" Line causes excessive conflict with the river, in comparison to the other alignments. The additional cost of the major bridge structures, retaining wall and/or cantilevered sections that would be necessary to maintain the river on the "24" Line would be 1.8 million dollars more than on the "21", "22" or "23" Lines, and 3.0 million dollars more than on the "20" Line. (See Total Cost Estimate Comparison).

Review Comments & Notes

RIVER ACCESS & CONFLICT COMPARISON

COMPARISON ITEMS	"20" AMOUNT	"20" POINTS	"21" AMOUNT	"21" POINTS	"22" AMOUNT	"22" POINTS	"23" AMOUNT	"23" POINTS	"24" AMOUNT	"24" POINTS
Total River Access, Miles....	4.128	8	4.128	8	4.128	8	2.301	4	1.287	2
Percent of Present Access Retained.........	71%	8	71%	8	71%	8	40%	4	22%	2
Present Access Road (PTW) Relocated, Miles........	0.627	4	0.414	8	0.551	6	0.118	10	0.682 (4)	2
Minor River Conflict, (1) Feet...................	1,000'	10	1,630'	4	1,500'	8	1,600'	6	2,200'	2
Major River Conflict, (2) Feet...................	1,410'	9	1,410'	9	1,490'	6	1,800'	4	3,650'	2
River Improvement (3).........	None	5	None	5	None	5	900'	10	None	5
River Access Continuous Between Henderson and Drexel.................	Yes	8	Yes	8	Yes	8	No	3	No	3
Total Points...........		52		50		49		41		18
HIGHWAY RATING INDEX.........	1		3		2		4		5	

(1) Encroachment on present river bed not requiring channel change or retaining wall.
(2) Encroachment on present river bed requiring undesirable channel change or retaining wall.
(3) Desirable channel change, flood plain improvement, etc.
(4) The access to the river is provided from two rest areas.

PART VIII - Table 5

MAINTENANCE COMPARISON

A. BASIS OF EVALUATION

Four items are evaluated which compare the maintenance problems presented by each alignment, rather than comparing maintenance on an equal cost-per-mile basis. These four items are:

(1) Snow Removal

This item would be relatively the same for any alignment, except for snow storage area. It is obvious that where a depressed median exists, the problem of snow removal is greatly minimized, as opposed to a barrier guard rail median section. Therefore, this item is evaluated upon the basis of which alignment provides the greatest percentage of depressed median section.

(2) Rock Removal

This item is evaluated on the basis of linear feet of cut ditches in which rock could possibly accumulate.

(3) Structure Maintenance

This item is evaluated on the basis that bridges and retaining walls present an additional maintenance problem for any alignment. Therefore, this evaluation is measured in linear feet of bridges and retaining wall.

(4) Sanding

Any alignment through the St. Regis canyon will necessarily present a sanding problem. It is the purpose of this evaluation to show which alignment will require the least amount of sanding under usual winter conditions.

It is known from experience that bridge decks require sanding for a more prolonged period than roadway sections of comparable horizontal and vertical design. Therefore, square feet of bridge deck is the unit employed for measurement.

In addition to bridge decks, we have considered any length of roadway having a grade of 3 percent or greater as presenting an additional sanding problem. The sum of these two items is rated as "linear feet of problem roadway".

B. EVALUATION SUMMARY

The total points scored by the hillside alignments in this comparison are quite close. The "20" Line, Template B, scored

Review Comments & Notes

the most total points and did consistently well in each individual item evaluated.

In three of the four items evaluated, the amounts that determined the points are quite comparable for all lines studied. The item where the greatest difference occurs is Structure Maintenance. The "20" Line scored highest here because of its minimum amount of structures.

Review Comments & Notes

M A I N T E N A N C E   C O M P A R I S O N

COMPARISON ITEMS	"20"				"21"				"22"				"23"		"24"	
	TEMPLATE A		TEMPLATE B		TEMPLATE A		TEMPLATE B		TEMPLATE A		TEMPLATE B		TEMPLATE A		TEMPLATE B	
	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS
Snow Removal: Percent of Roadway with Depressed Median..............	9.08%	2	60.88%	14	9.56%	8	34.00%	12	9.48%	6	33.71%	10	9.41%	4	100.00%	16
Rock Removal: Linear Feet of Cut Ditch...........	14,850'	12	15,790'	6	14,032'	16	14,920'	10	14,353'	14	15,190'	8	20,265'	4	22,161'	2
Structure Maintenance: Linear Feet of Structures..........	1,940'	15	1,940'	15	3,092'	11	3,092'	11	3,156'	7	3,156'	7	4,212'	4	9,300'	2
Sanding: Linear Feet of Problem Roadway.....	7,241'	11	7,241'	11	7,997'	5	7,997'	5	6,156'	15	6,156'	15	7,263	8	10,044'	2
Total Points......		40		46		46		40		40		40		20		22
HIGHWAY RATING INDEX...	3		1		3		4		2		3		6		5	

PART VIII - Table 6

CONSTRUCTION METHODS COMPARISON

A. BASIS OF EVALUATION

We have evaluated three items which should be considered from the standpoint of construction only. These items have been evaluated from the standpoint of convenience to the motorist during construction and according to the simplicity of construction by the contractor. These three items are:

(1) Traffic Control

Evaluation is based upon how the traffic is to be routed during construction. The prime considerations are the amount of PTW undisturbed and available as detour, the amount of detour that would require additional construction, and the amount of detour which may be located off and separated from construction as opposed to the amount of detour that must necessarily be located along or on the construction.

(2) Earthwork Balance

Evaluation is based upon the total earthwork balance for each alignment and upon the location of balance points throughout each alignment.

(3) Simplicity

In this evaluation, the alignment requiring the least amount of structures is considered to be simpler from the standpoint of construction. This consideration is based primarily upon the difference in construction time between structure erection and roadway preparation, the difference being that the latter of these two operations enjoys nearly an unlimited construction season.

For these reasons, the total square feet of major structures and the linear feet of retaining wall per alignment are the units employed for evaluation.

B. EVALUATION SUMMARY

Based upon this evaluation, the "20" Line would be the least complicated to build.

In the traffic control comparison, the "20", "21" and "22" Lines were almost identical. The problem of maintaining traffic during the construction period would be more acute on the "23" and "24" Lines due to a lack of available space for a detour.

Review Comments & Notes

In the earthwork balance comparison, the "20" Line scored the highest. It scored higher than the "21" or "22" Lines because there are two timely balance points near the horseshoe bend area on the "20" Line which do not occur on the "21" or "22" Lines. Aside from that, the earthwork on all three lines is the same. It has been pointed out previously that the "23" and "24" alignments create a waste condition of over 800 thousand cubic yards and present less favorable haul conditions.

Simplicity, when scored in proportion to the amount of structures required on each alignment, went easily to the "20" Line; this alignment having far less major and minor structure requirements.

Review Comments & Notes

CONSTRUCTION METHODS COMPARISON					
COMPARISON ITEMS	"20"	"21"	"22"	"23"	"24"
	POINTS	POINTS	POINTS	POINTS	POINTS
Traffic Control..................	6	10	8	4	2
Earthwork Balance...............	10	7	7	3	3
Simplicity......................	10	8	6	3	3
Total Points...............	26	25	21	10	8
HIGHWAY RATING INDEX.............	1	2	3	4	5

PART VIII - Table 7

CONSTRUCTION METHODS COMPARISON

TRAFFIC CONTROL

COMPARISON ITEMS	"20"		"21"		"22"		"23"		"24"	
	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS
(Comparison in Miles)										
Length of Detour Comprised of PTW..........	4.128	8	4.128	8	4.128	8	2.301	4	0.905	2
Length of Detour to be Constructed.........	2.493	6	2.280	10	2.417	8	3.811	4	6.500	2
Length of Detour Separated from Construction.........	4.128	8	4.128	8	4.128	8	3.693	4	2.131	2
Length of Detour on or Adjacent to Construction...	2.493	6	2.280	10	2.417	8	3.107	4	4.369	2
Total Points...........		28		36		32		16		8
HIGHWAY RATING INDEX.........	3		1		2		4		5	

PART VIII - Table 7a

CONSTRUCTION METHODS COMPARISON

EARTHWORK BALANCE

COMPARISON ITEMS	"20"		"21"		"22"		"23"		"24"	
	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS
Does the Total Earthwork Balance?.........	Yes	8	Yes	8	Yes	8	No	3	No	3
Total Number of Balance Points.............	10	10	8	7	8	7	4	3	4	3
Average Distance Between Balance Points (Miles).....	0.528	10	0.612	8	0.618	6	1.120	4	1.196	2
Total Points............		28		23		21		10		8
HIGHWAY RATING INDEX.........	1		2		3		4		5	

PART VIII - Table 7b

CONSTRUCTION METHODS COMPARISON

SIMPLICITY

COMPARISON ITEMS	"20"		"21"		"22"		"23"		"24"	
	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS
Total Linear Feet Major Structures..........	530	10	1,682	6	1,666	8	2,412	4	2,650	2
Total Linear Feet Retaining Wall............	1,410	9	1,410	9	1,490	9	1,800	4	6,650	2
Total Points...........		19		15		14		8		4
HIGHWAY RATING INDEX.........	1		2		3		4		5	

PART VIII - Table 7c

SCENIC EVALUATION

A. BASIS OF EVALUATION

Today, highway planners and designers are placing ever - increasing importance on a highway's scenic value and beauty. In a location such as the St. Regis canyon, this is especially true. We felt an attempt should be made to evaluate and compare the scenic value and beauty of the alignments presented in this report.

Three items have been chosen as the basis of this evaluation; they are:

(1) Panorama

In line with the definition of the word, each line was evaluated on the basis of which line presented the best "unobstructed or complete view of a region in every direction". To facilitate this comparison, a field survey was made comparing the panorama from comparable positions on each alignment. Numerous photographs were taken for comparison and a few examples are presented in Appendix A.

(2) Undesirable Cut Faces

The majority opinion seems to be that large exposed cut faces are detrimental to the over-all beauty of a highway. Therefore, this item was evaluated on the basis of the alignment presenting the least square yards of cut face.

(3) Scenic Value Enhanced by High Fills

This item may be more or less arbitrary than the others, but we feel the view from certain high fills should be quite unusual. Generally, the view on the north side of the highway will be of a cut face or steep hillside. This evaluation is based upon the number of places where, due to a high fill, the view from the highway is unobstructed on both sides of the highway.

B. EVALUATION SUMMARY

Following a field investigation, it was concluded the panorama from any of the hillside alignments would be quite impressive, while the view from the canyon floor would be more channeled and restricted. It was also concluded a depressed median section offered a more pleasing view than a barrier guard rail section, particularly to westbound traffic. Therefore, the "20",

Review Comments & Notes

"21" and "22" Template B alignments received equal first-place ratings. These same alignments with Template A received equal second-place ratings. Because the "23" Line is elevated for a mile across the horseshoe bend area, it was rated one place higher than the "24" Line.

All alignments studied in this report had considerable amounts of cut faces. The points were simply assigned according to the measured amounts, the "21" Line, Template A, having slightly less than any other.

The high fills which should offer an extraordinary panorama were tabulated and the "20" and "21" Lines received equal first place ratings.

The composite total of the scenic evaluation gave the "21" Line, Template B, the most total points.

Review Comments & Notes

SCENIC EVALUATION

COMPARISON ITEMS	"20"				"21"				"22"				"23"		"24"	
	TEMPLATE A		TEMPLATE B		TEMPLATE A		TEMPLATE B		TEMPLATE A		TEMPLATE B		TEMPLATE A		TEMPLATE B	
	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS	AMOUNT	POINTS
Panorama..............	*	8	*	14	*	8	*	14	*	8	*	14	*	4	*	2
Total Area Cut Faces (Square Yards).......	298,169	12	372,711	2	260,551	16	325,689	8	264,710	14	330,888	6	312,133	10	330,943	4
Number of Areas Where View is Enhanced Over a High Fill.....	4	13	4	13	4	13	4	13	3	7	3	7	0	3	0	3
Total Points......		33		29		37		35		29		27		17		9
HIGHWAY RATING INDEX...	3		4		1		2		4		5		6		7	

* Value judgment based upon field survey; see "Basis of Evaluation" on preceding page.

PART VIII - Table 8

UTILITIES COMPARISON

A. BASIS OF EVALUATION

This evaluation is based upon what effect the new interstate highway will have on future location of utilities through this area. The cost of relocating existing utilities has been evaluated under "Annual Cost". The purpose of this evaluation is to determine which alignment will present the most versatility to the utility companies for relocating existing utilities and for future location of utilities.

B. EVALUATION SUMMARY

The most important consideration in this evaluation is the "20", "21" and "22" Lines provide the area adjacent to the present traveled way as a possible location for the utilities. On the "23" and "24" Lines, this area is completely taken up by the proposed interstate. It is doubly important when one considers that the PTW can be maintained from Henderson to Drexel under proposed alignments "20", "21" and "22".

If, on the other hand, the utility companies chose to ignore the PTW area as a possible choice for location or relocation of their respective installations, the evaluation of location and access to them becomes basically the same for any of the alignments presented in this report.

Because of the foregoing considerations, the "20", "21" and "22" Lines have been assigned equal higher ratings over equal lower ratings for the "23" and "24" Lines.

Review Comments & Notes

UTILITIES COMPARISON

COMPARISON ITEMS	"20"	"21"	"22"	"23"	"24"
	POINTS	POINTS	POINTS	POINTS	POINTS
Versatility of Location[a]	6	6	6	3	3
Total Points	6	6	6	3	3
HIGHWAY RATING INDEX	1	1	1	2	2

(a) For explanation of how points were assigned, see "Basis of Evaluation" on preceding page.

PART VIII - Table 9

RECOMMENDATIONS

We recommend the "20" Line, Template B, be selected for final design and construction of that portion of Interstate Route 90 through the St. Regis canyon designated as Drexel East and West.

This recommendation is based upon the "Highway Rating Index" which is the end result of a careful point scoring of all those aspects of route location analysis which we feel are important and necessary to an investigation of this kind.

The advantages of this alignment can be found in several different areas. By eliminating several costly structures, it presents the second lowest construction and total annual cost of all lines studied. It has the greatest percentage of wide median cross section, except for the "24" Line which is all wide median or independent alignment. The "20" Line will be the easiest to construct and maintain, and offers the driving public a truly scenic route through the canyon. It provides the opportunity to maintain a riverside access road through the canyon with the least amount of additional construction and the least amount of conflict with the St. Regis River. It also provides a potential area with access for utilities.

Review Comments & Notes

HIGHWAY RATING INDEX SUMMARY

COMPARISON ITEMS	"20"		"21"		"22"		"23"	"24"
	TEMPLATE A	TEMPLATE B	TEMPLATE A	TEMPLATE B	TEMPLATE A	TEMPLATE B	TEMPLATE A	TEMPLATE B
Horizontal Alignment........	3.750	3.750	11.250	11.250	8.250	8.250	6.000	1.500
Vertical Alignment........	2.250	2.250	6.750	6.750	9.750	9.750	12.000	4.500
Cross Section......	1.500	10.500	6.000	9.000	4.500	7.500	3.000	12.000
Annual Costs.......	12.000	10.500	7.500	6.000	9.000	4.500	3.000	1.500
River Access & Conflict.........	11.250	11.250	5.250	5.250	8.250	8.250	3.000	1.500
Maintenance........	6.250	10.000	6.250	5.000	8.750	6.250	1.250	2.500
Construction.......	9.375	9.375	6.875	6.875	4.375	4.375	2.500	1.250
Scenic............	7.500	5.625	10.000	8.750	5.625	3.750	2.500	1.250
Utilities.........	6.875	6.875	6.875	6.875	6.875	6.875	1.875	1.875
Total Points..	60.750	70.125	66.750	65.750	65.375	59.500	35.125	27.875
HIGHWAY RATING INDEX...........	5	1	2	3	4	6	7	8

Appendix A

PHOTO NO. 1

View looking Northwest
Location: Henderson Interchange Area
Station 105+00
Proposed Rest Area on Left

Review Comments & Notes

PHOTO NO. 2

View looking South
Location: Station 269+00 "20" Line
Unsightly Utility Poles Along Present U.S. No. 10

Review Comments & Notes

PHOTO NO. 3

View looking Southeast
Location: Station 152+00 "20" Line
Fishing Access from Present U.S. No. 10

Review Comments & Notes

PHOTO NO. 4

View Looking Northwest
Location: Station 155+00 "20" Line
Tree-top Panorama up St. Regis Canyon

Review Comments & Notes

PHOTO NO. 5

View looking Southeast
Location: Station 208+00 "20" Line
St. Regis River at Low-water Level

Review Comments & Notes